The Engineer

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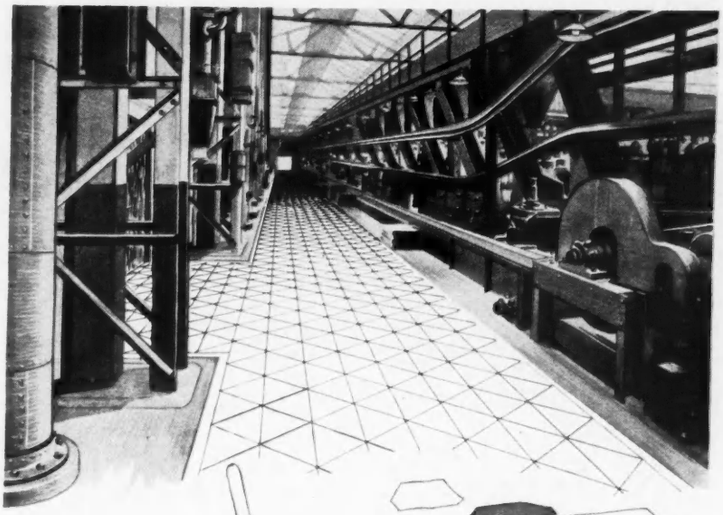

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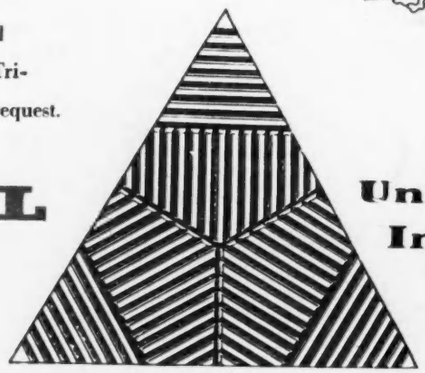

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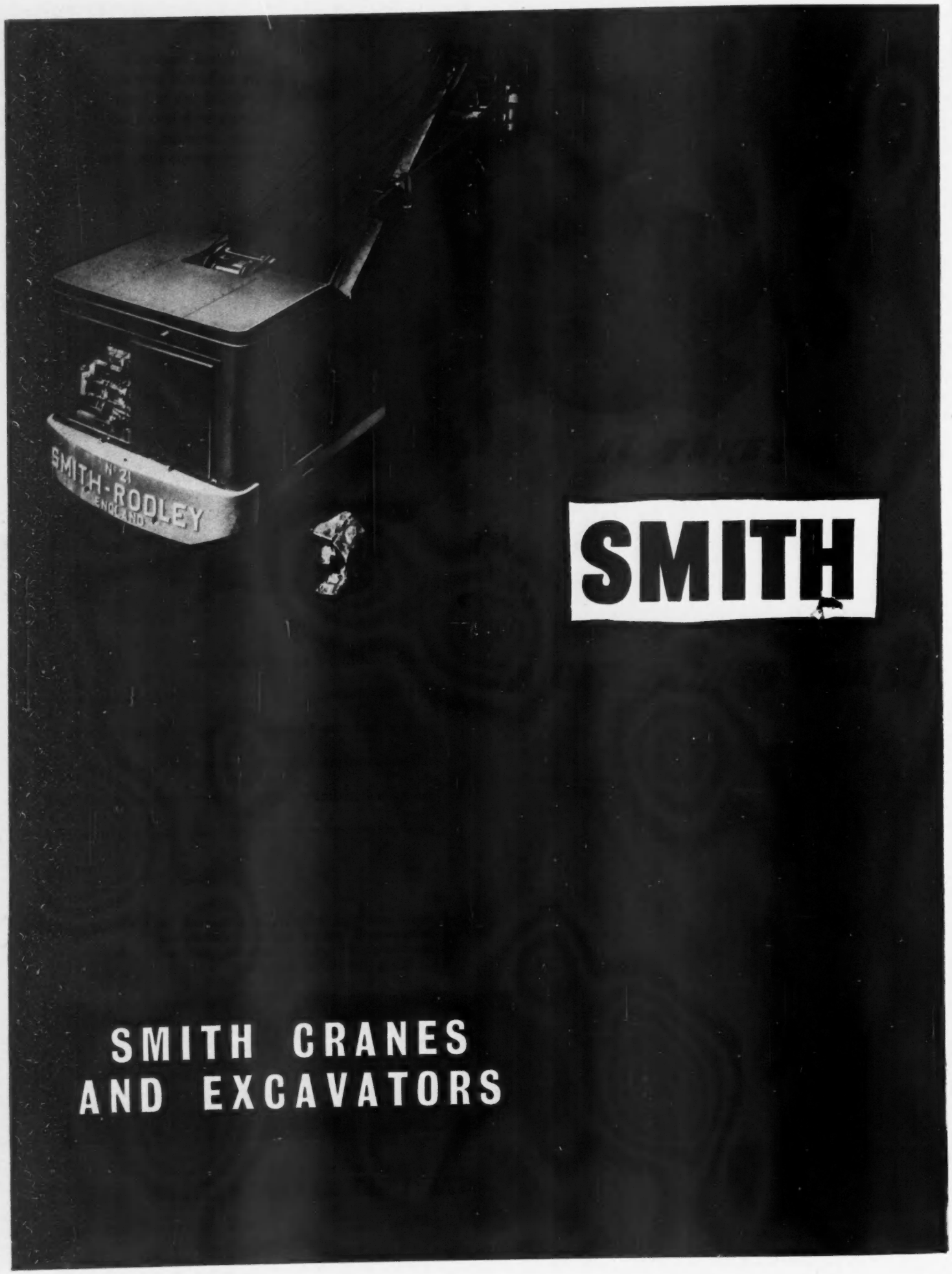
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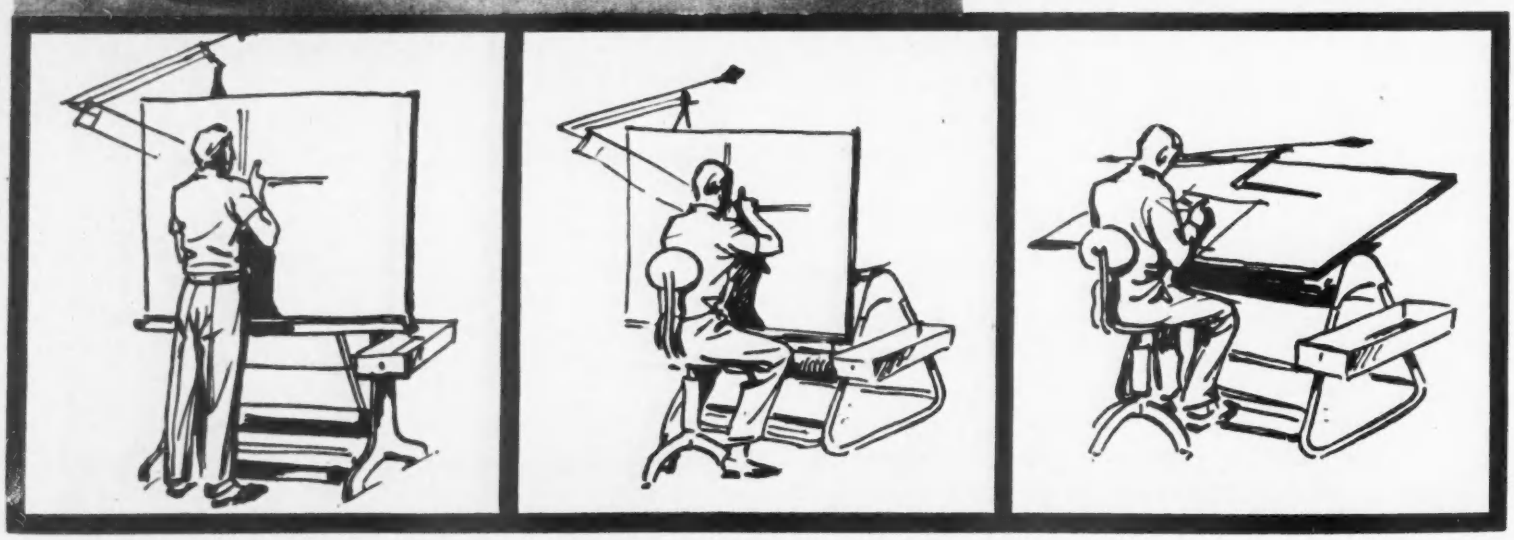

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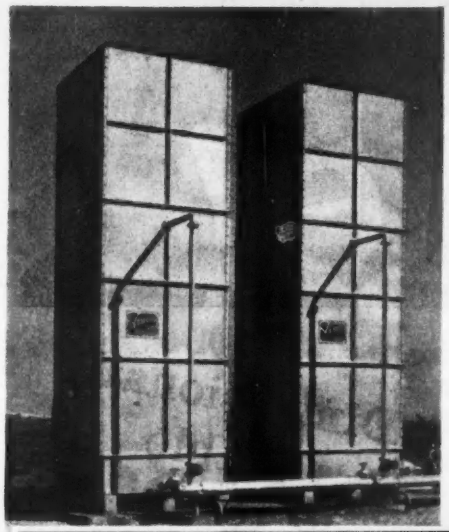

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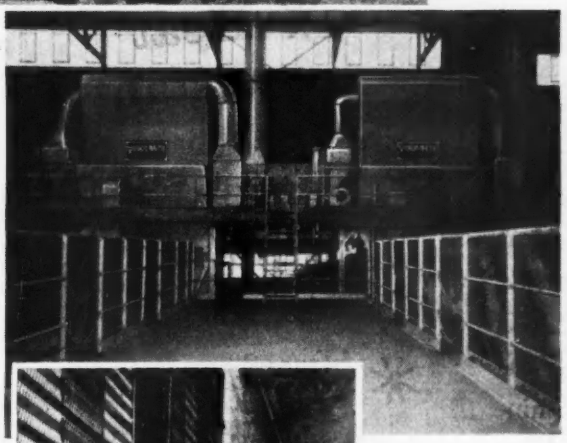

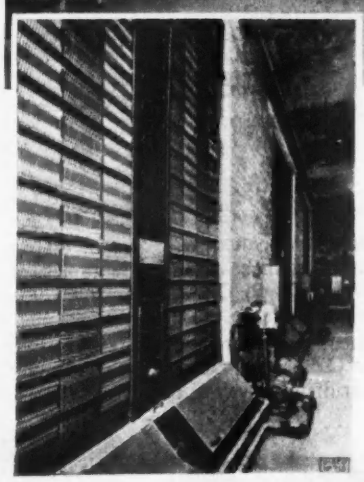

Above—Two of three "Visco-Beth" Dust Collectors at the Cauldon Works of the Assoc. Portland Cement Manufacturers, Ltd.

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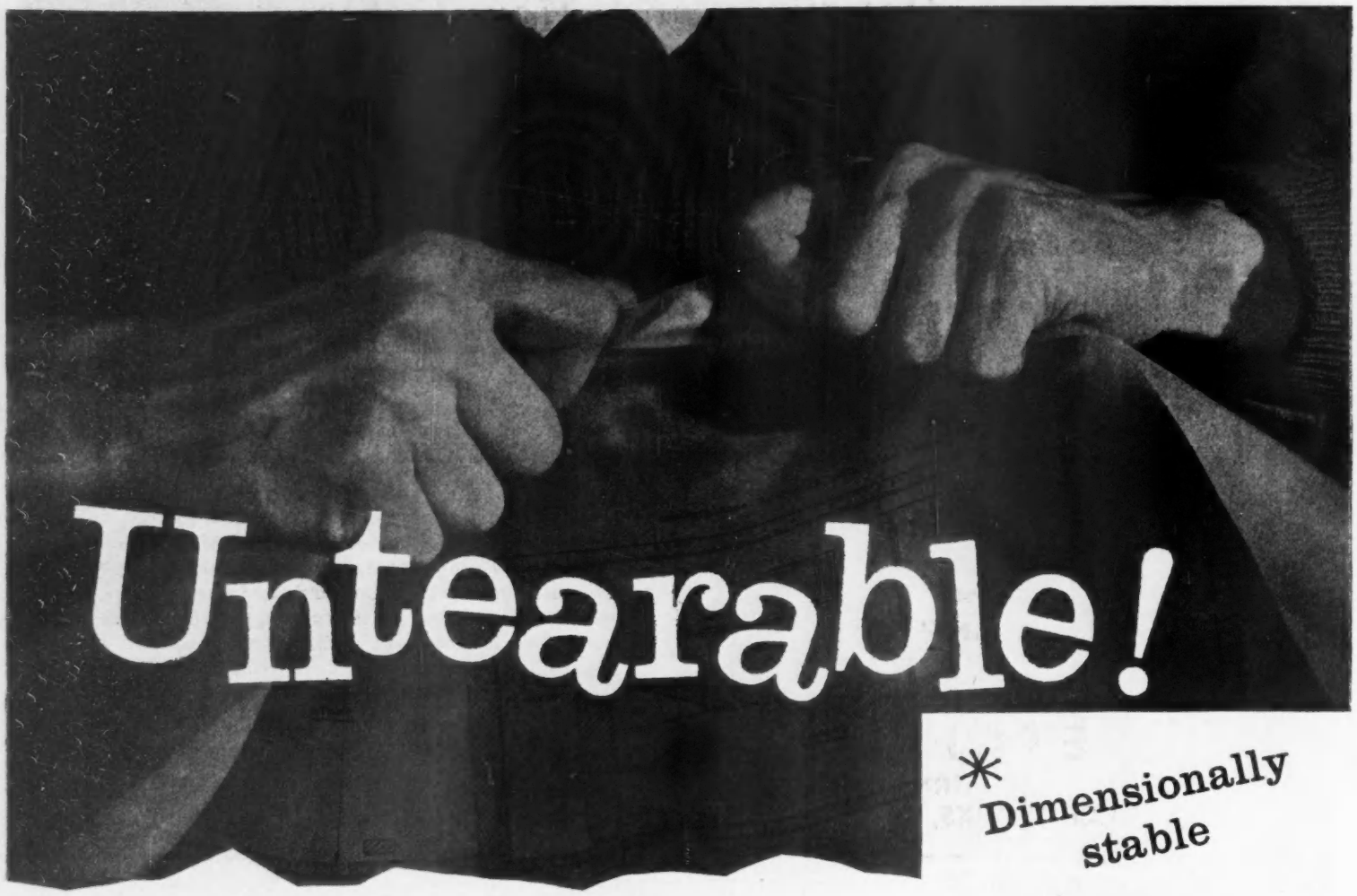

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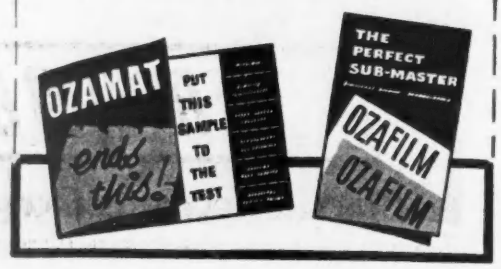

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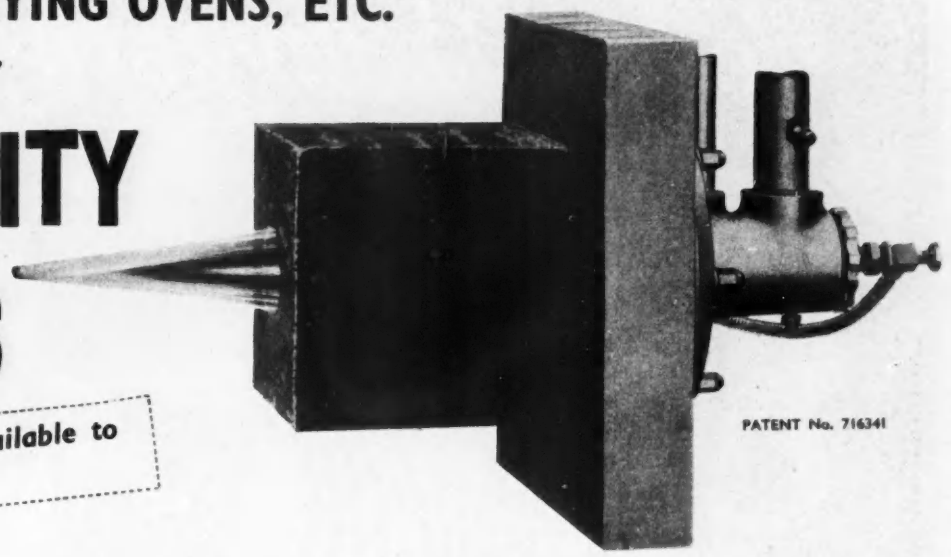

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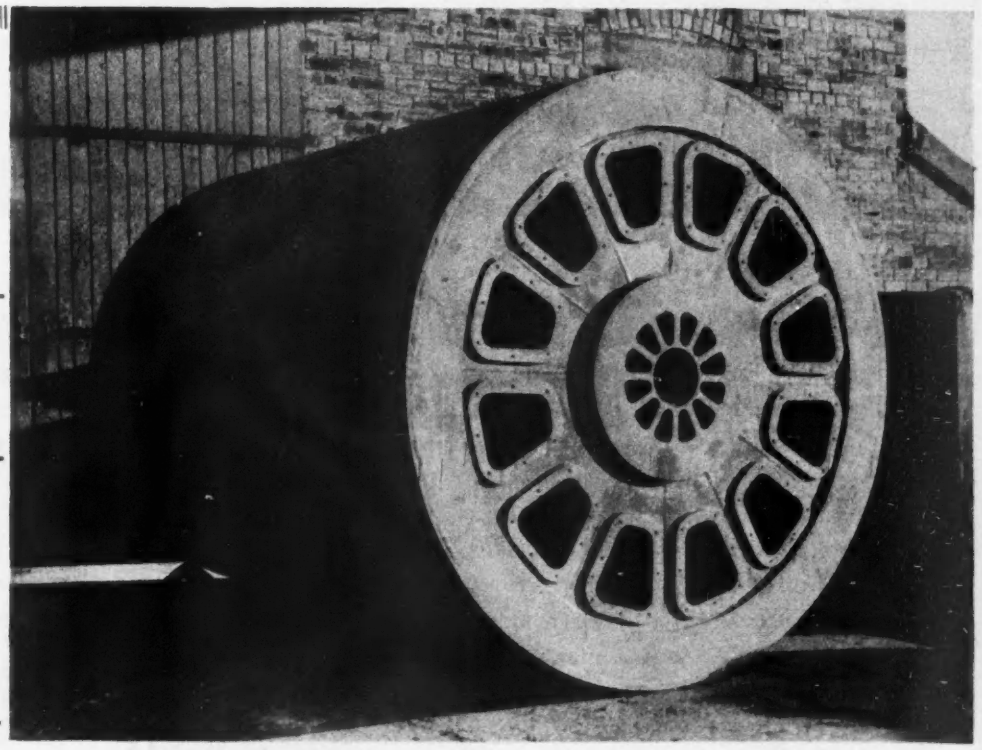

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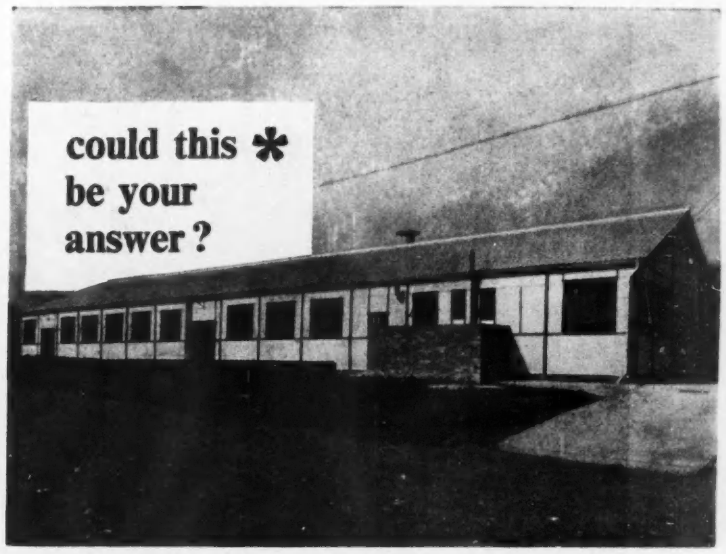

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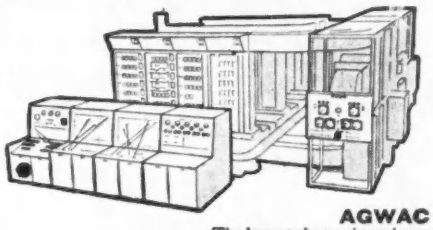

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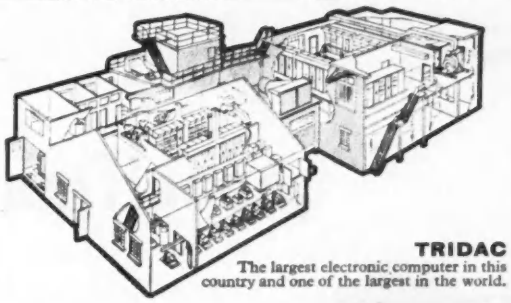

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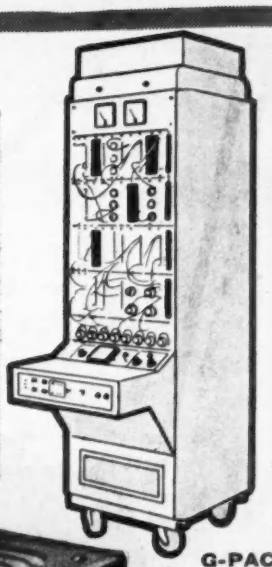

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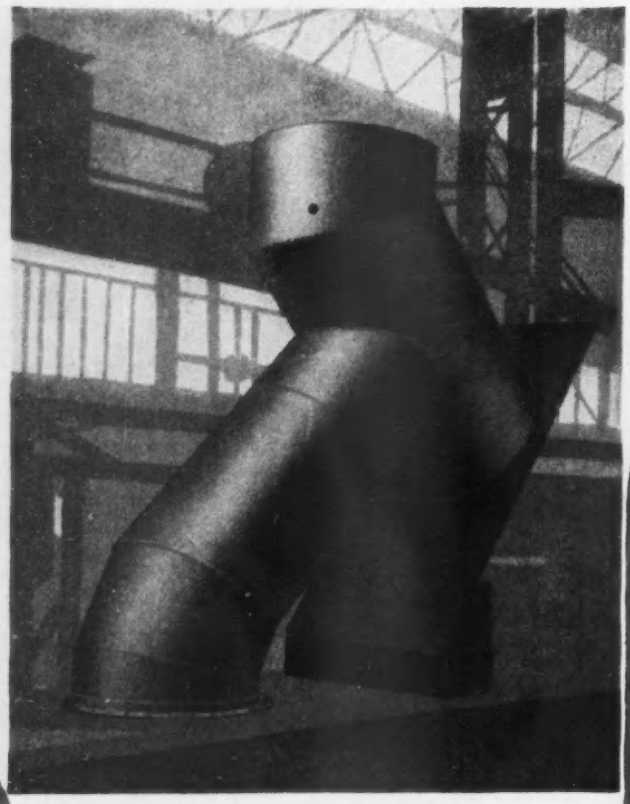

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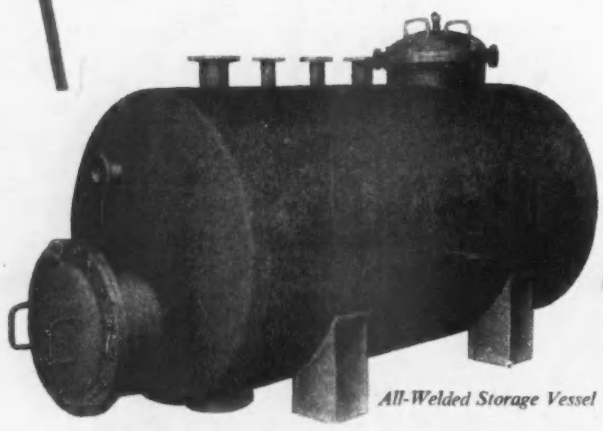

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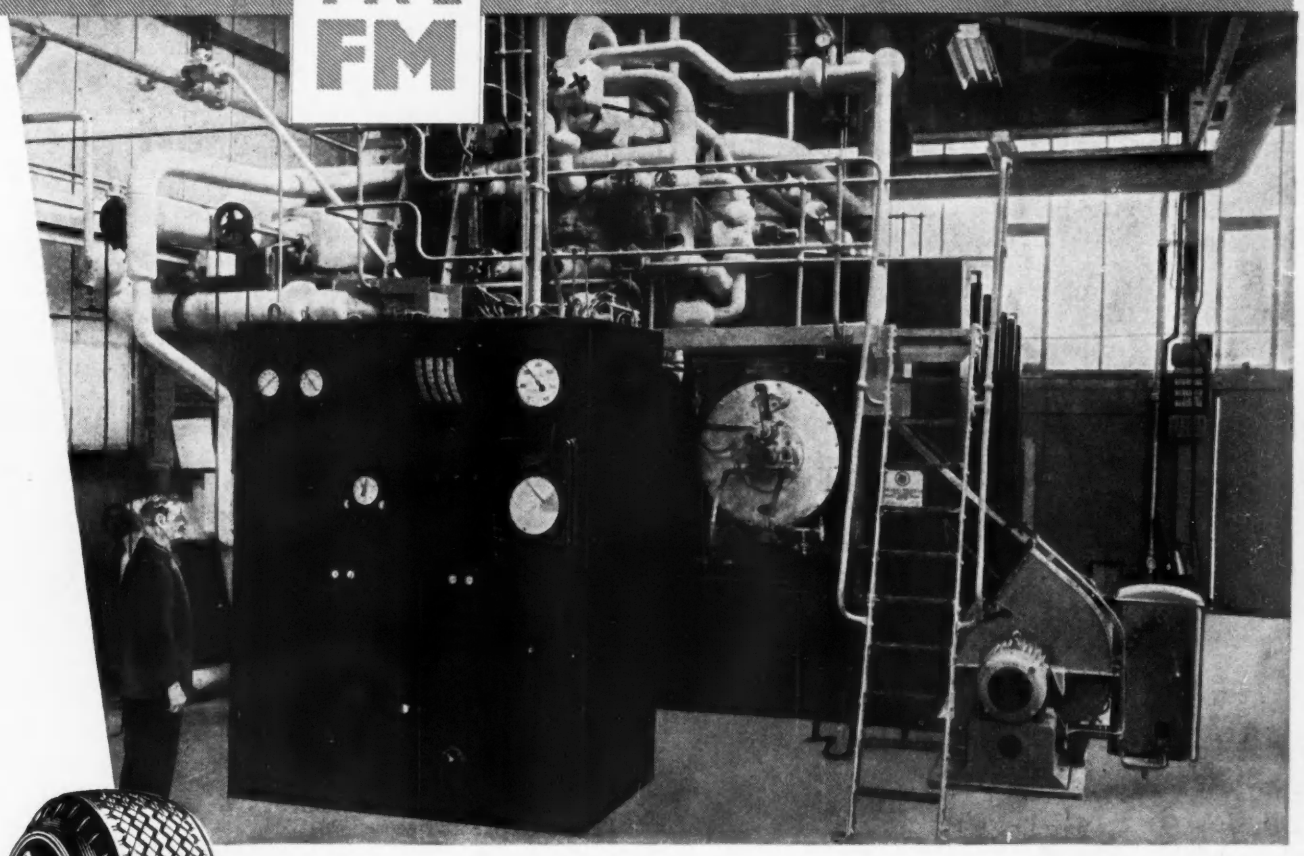

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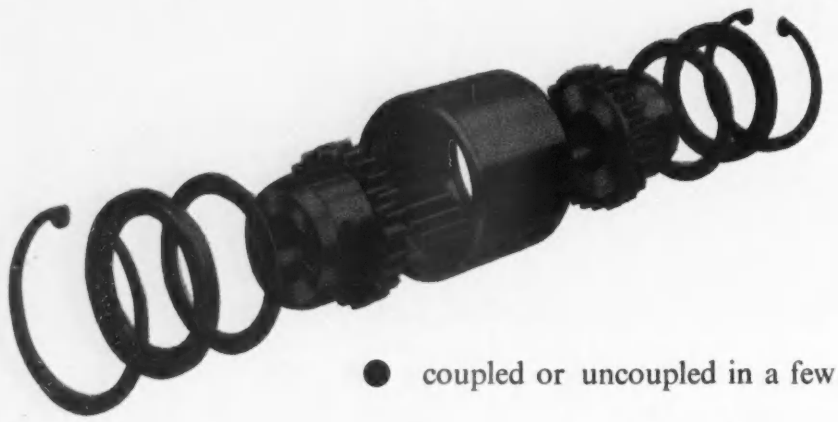

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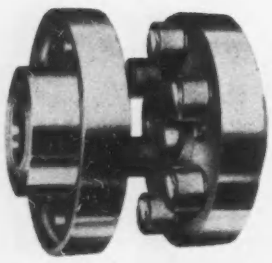

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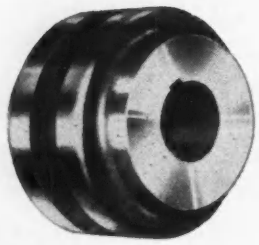

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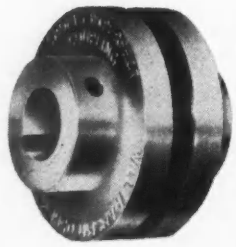

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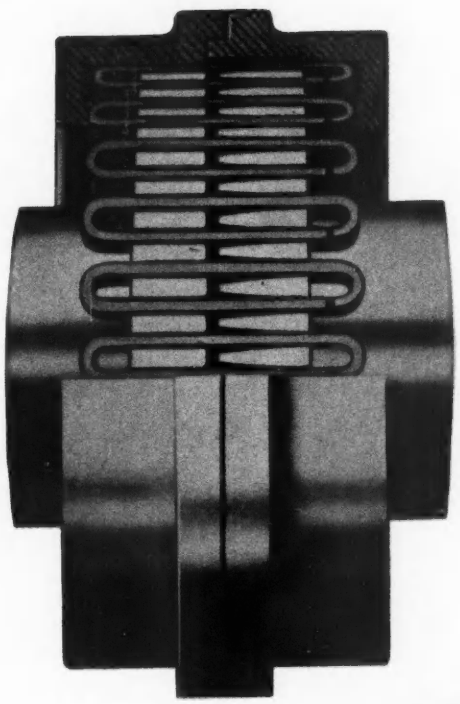

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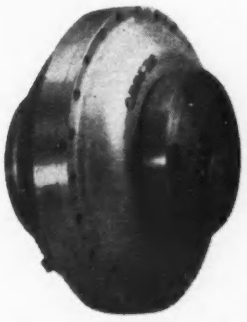

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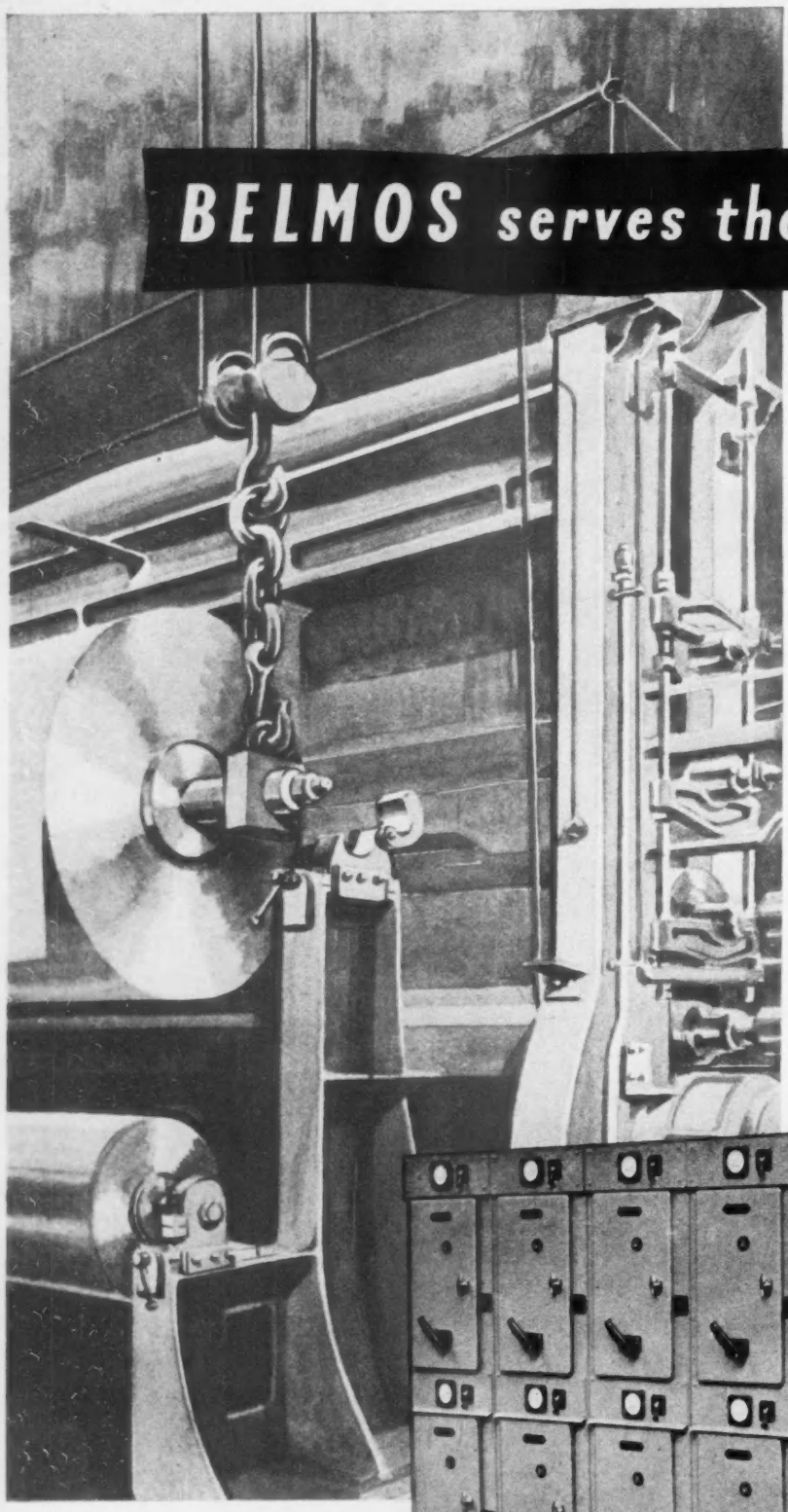

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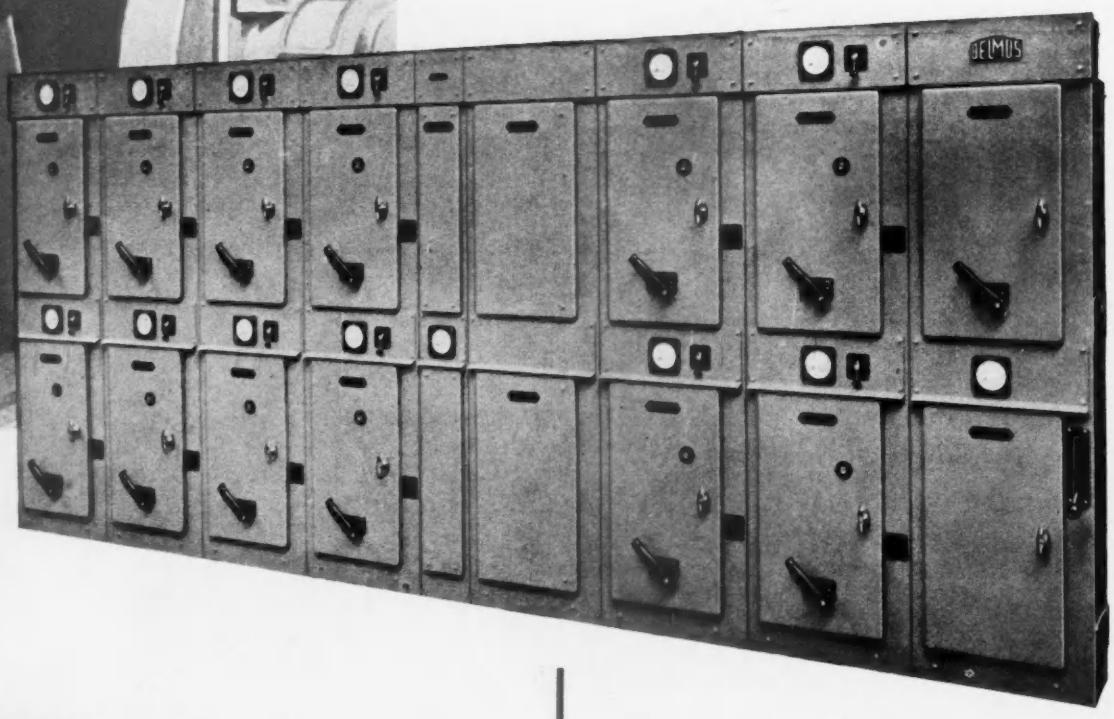

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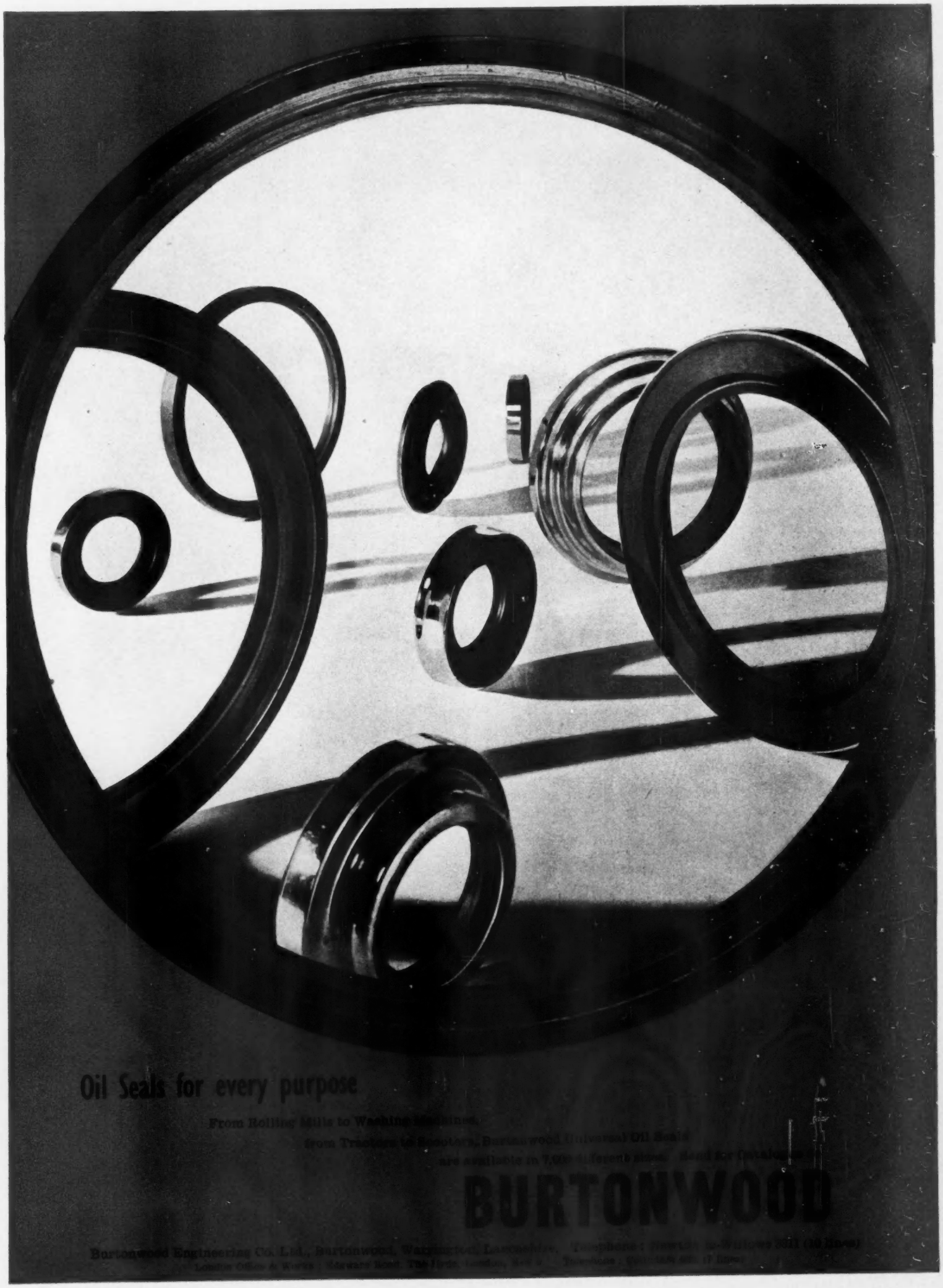
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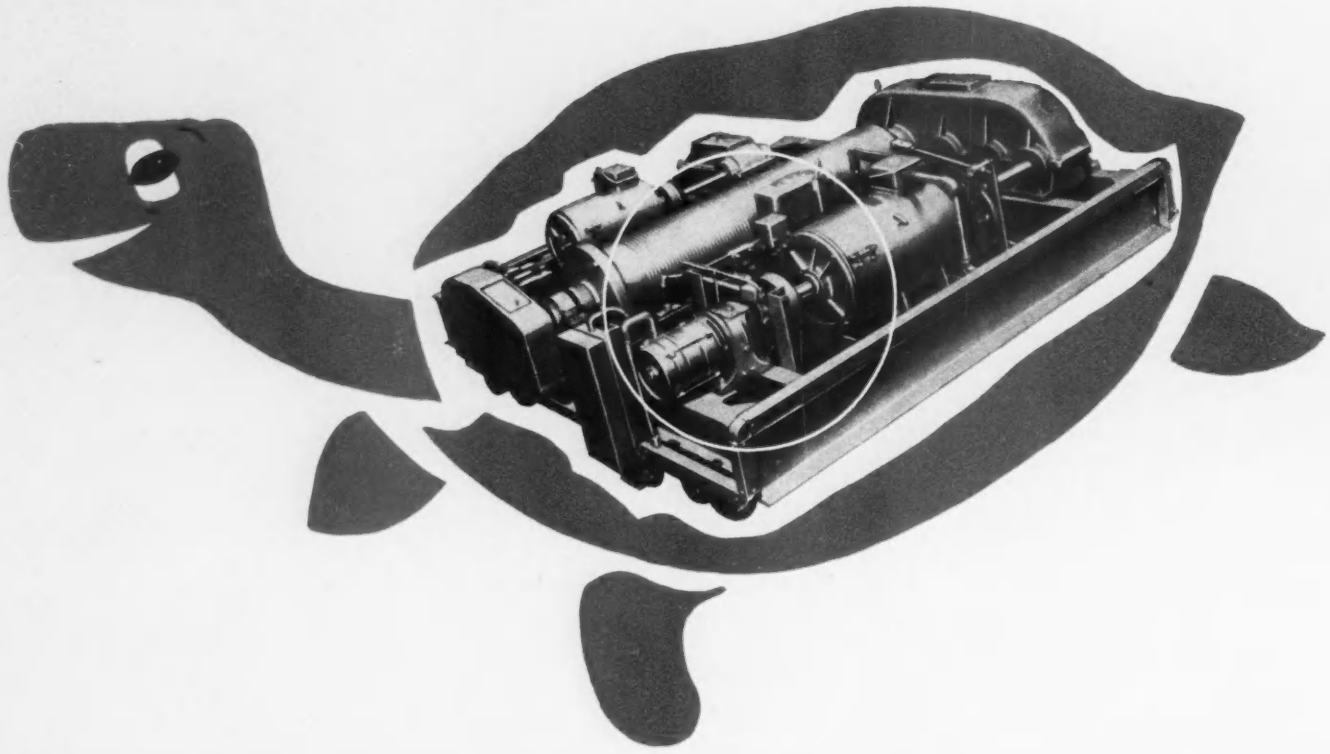

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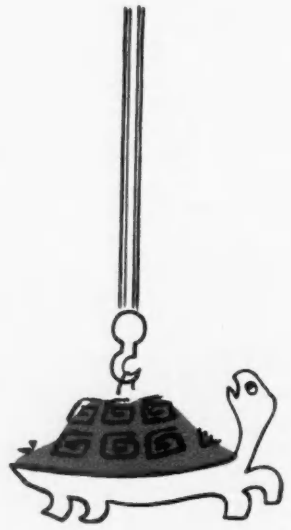

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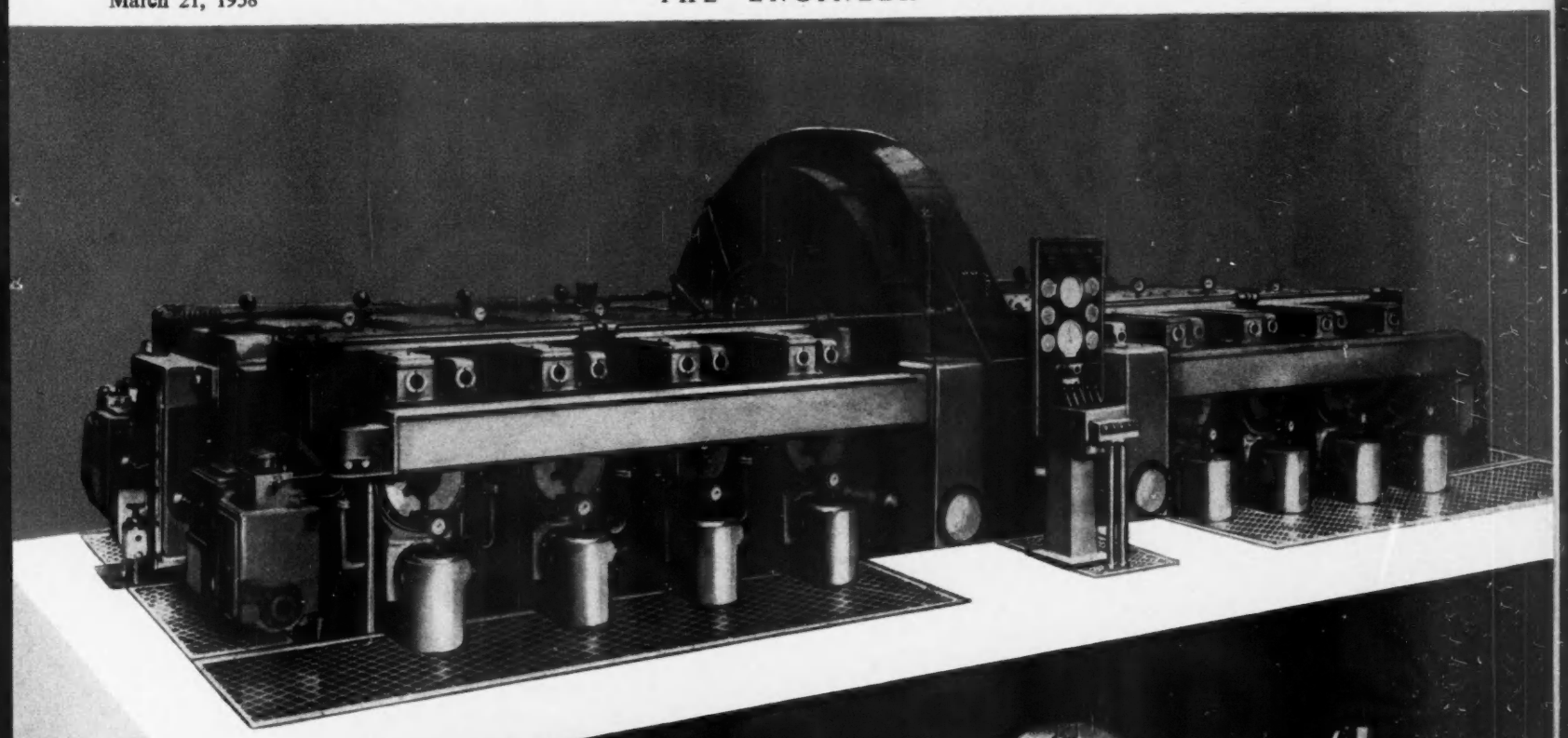

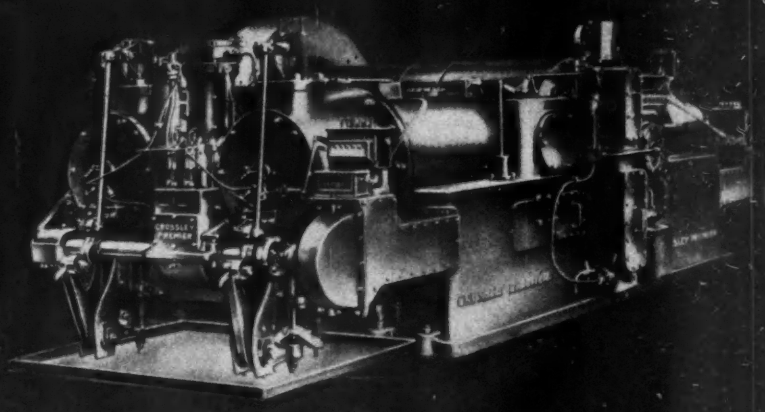

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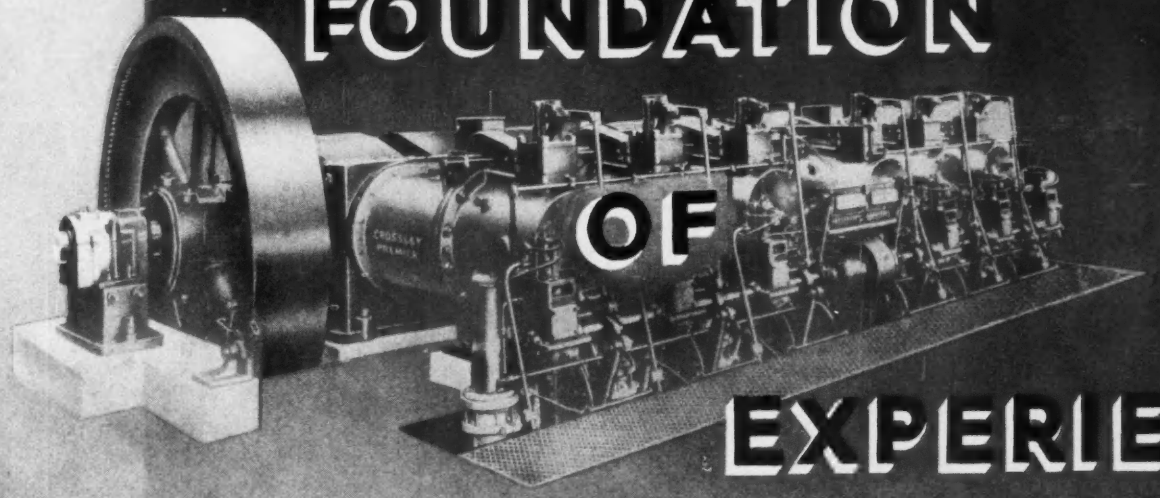

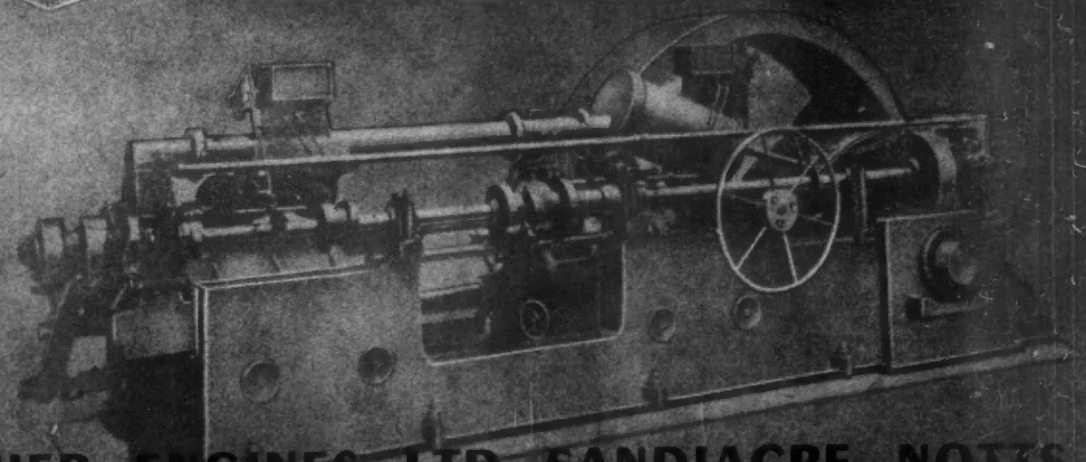

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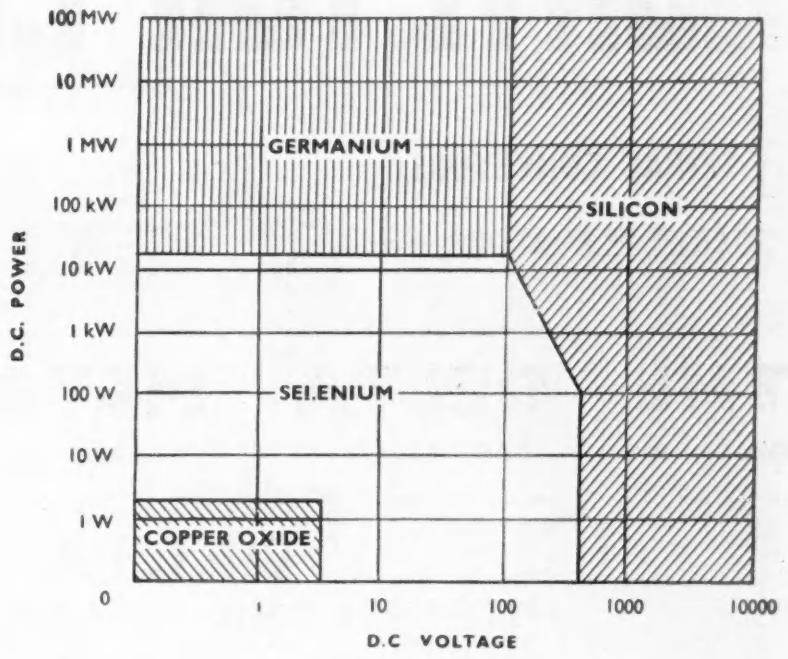

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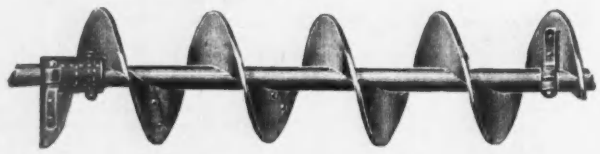

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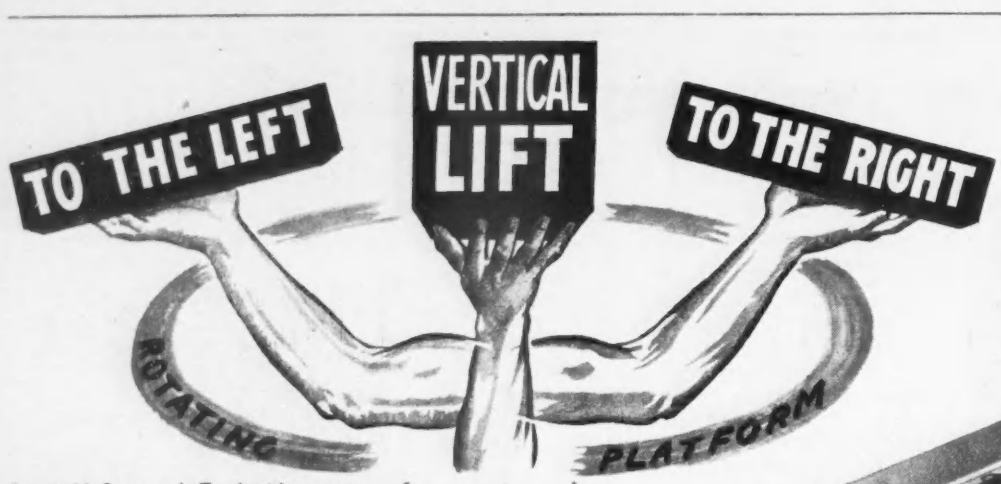

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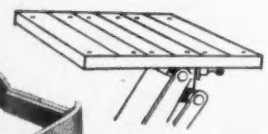

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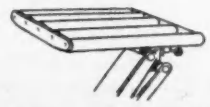

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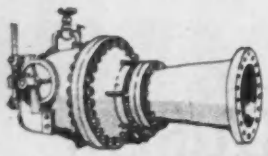
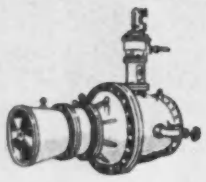
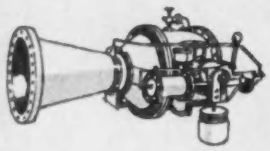


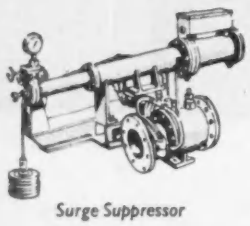
Pipeline Control Valve



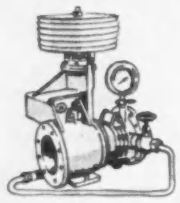
Discharge Regulator



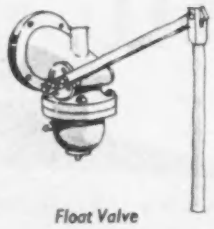
Self Closing Valve



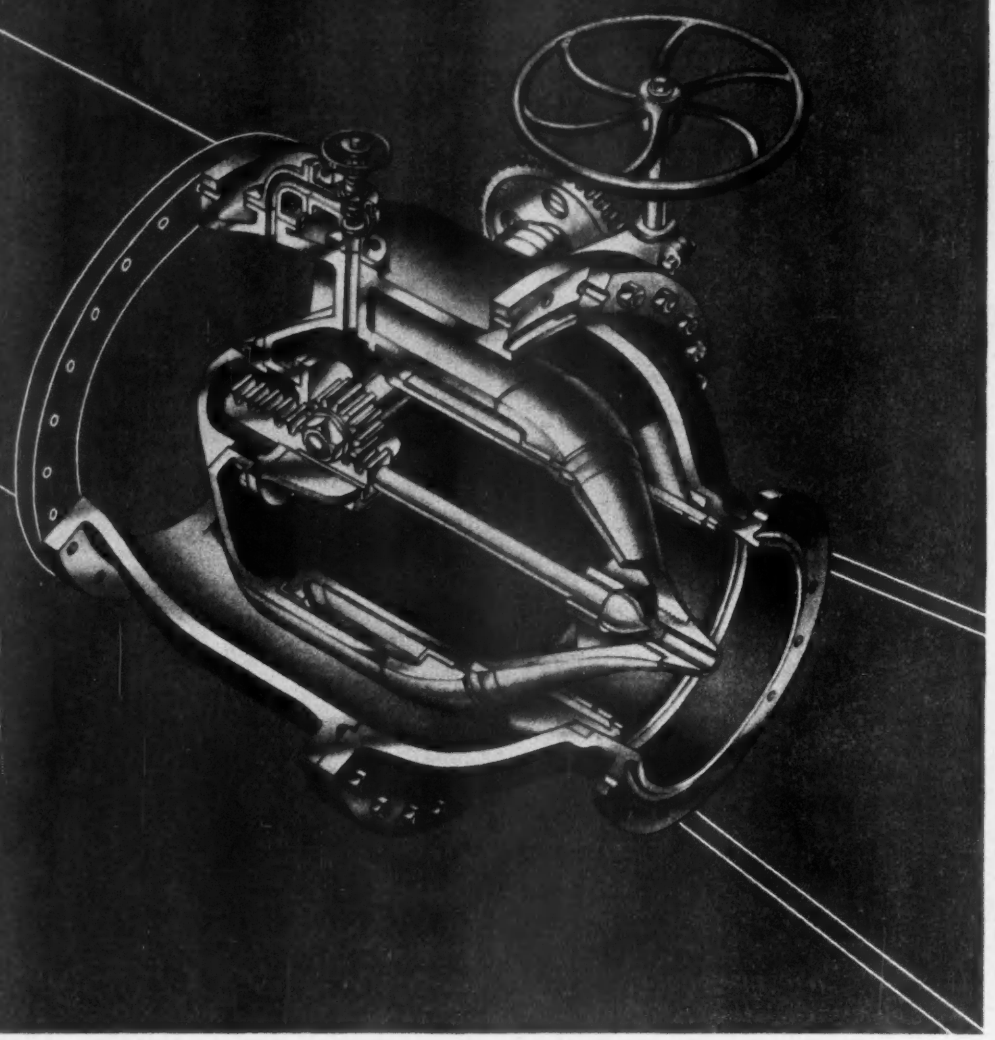
Surge Suppressor



Pressure Reducing Valve



Float Valve



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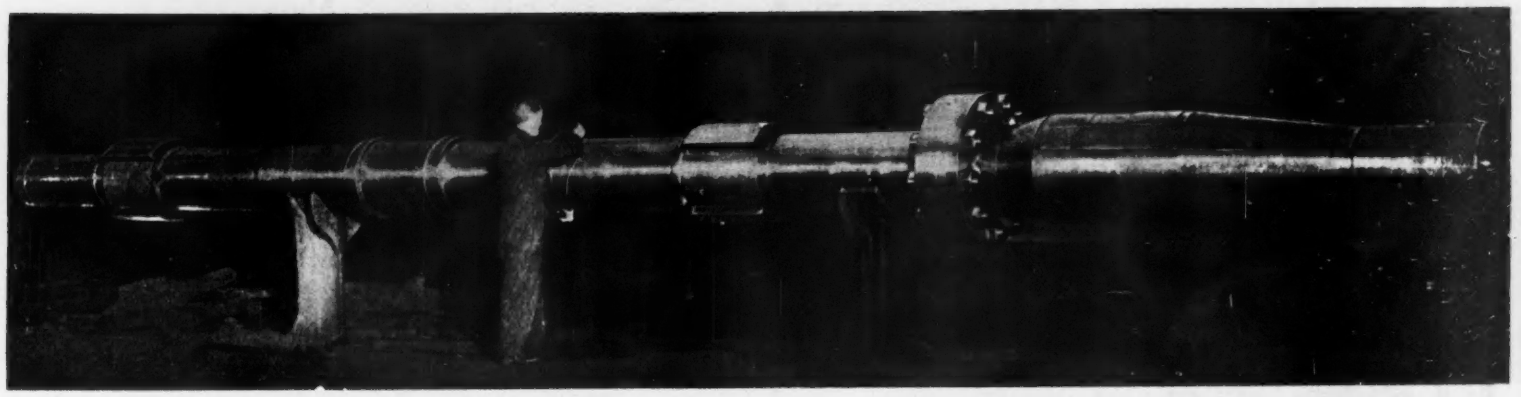

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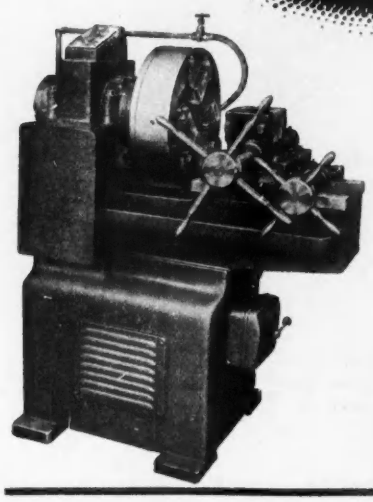

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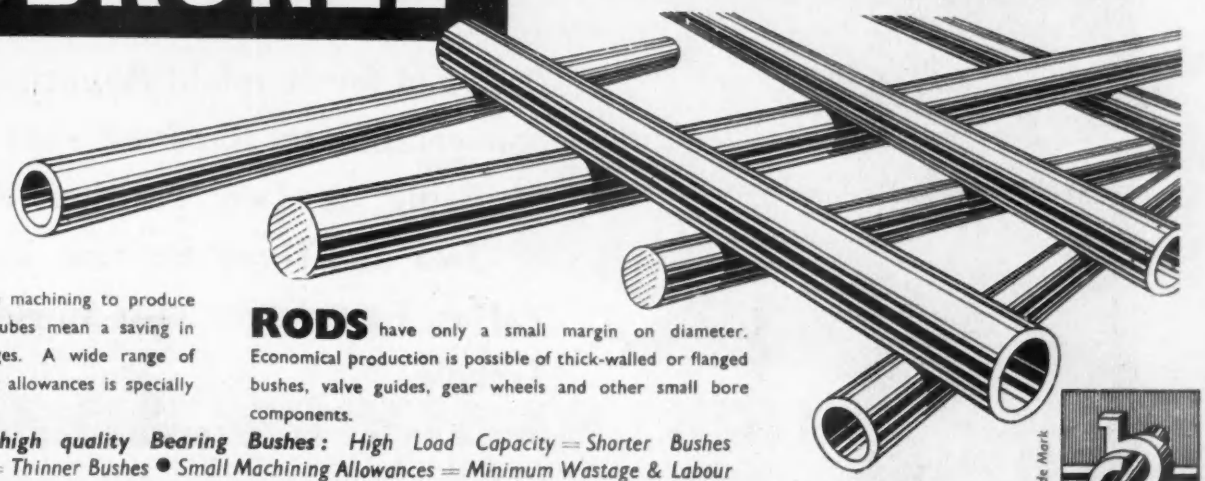

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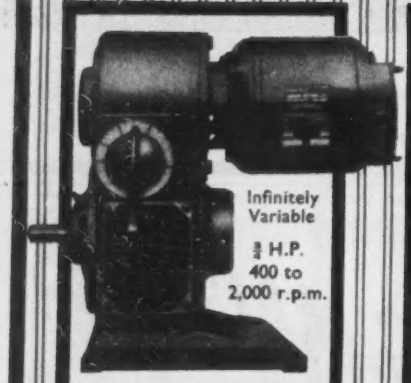

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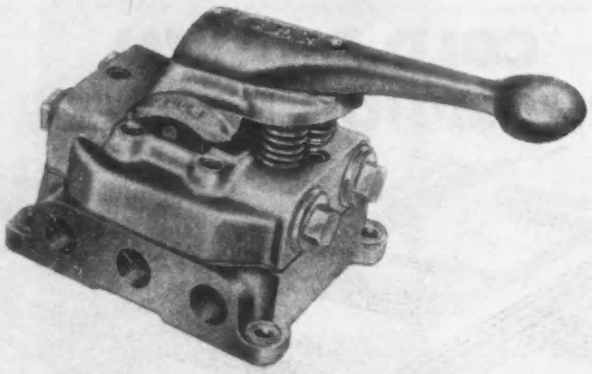

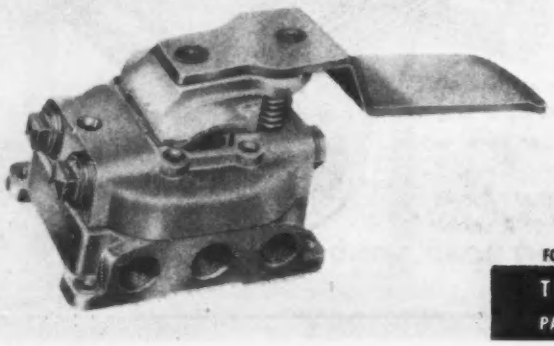

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Melting capacity:	440 lbs Brass/h
	300 lbs Gun metal/h
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Connected load:	50 kVA

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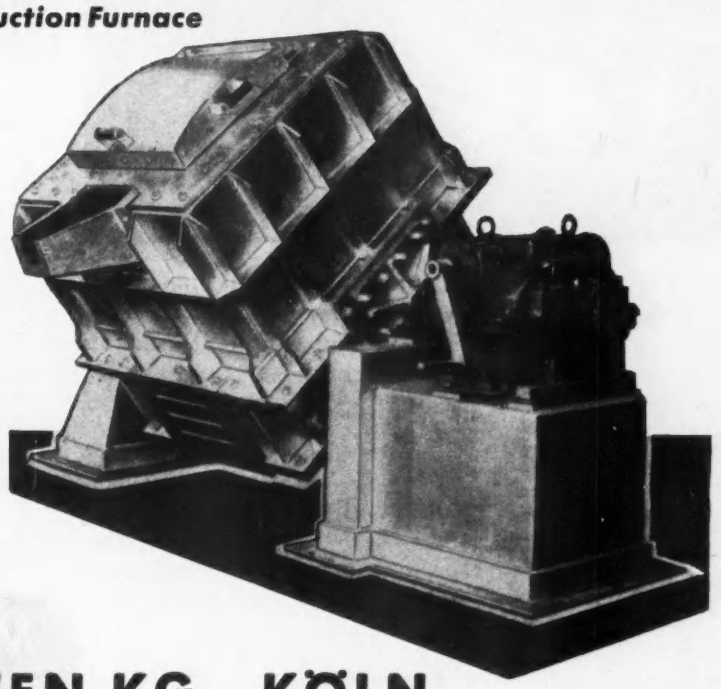

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GERMAN INDUSTRIES FAIR, HANNOVER. 27 April—6 May, 1958. Please visit us at STAND No. 25, HALL 13.

Wide waters . . . . .

The Kariba Gorge

The upstream entrance to the Kariba Gorge, seen from a promontory at the confluence of the Sanyati and Zambesi Rivers.

THE wide waters of the mighty Zambesi will soon be harnessed to provide power for the development of the vast territory of Central Africa. A dam now being constructed at Kariba will form the largest man-made lake in the world by impounding the waters of the river to provide a controlled flow to the hydro-electric machinery in two power stations.

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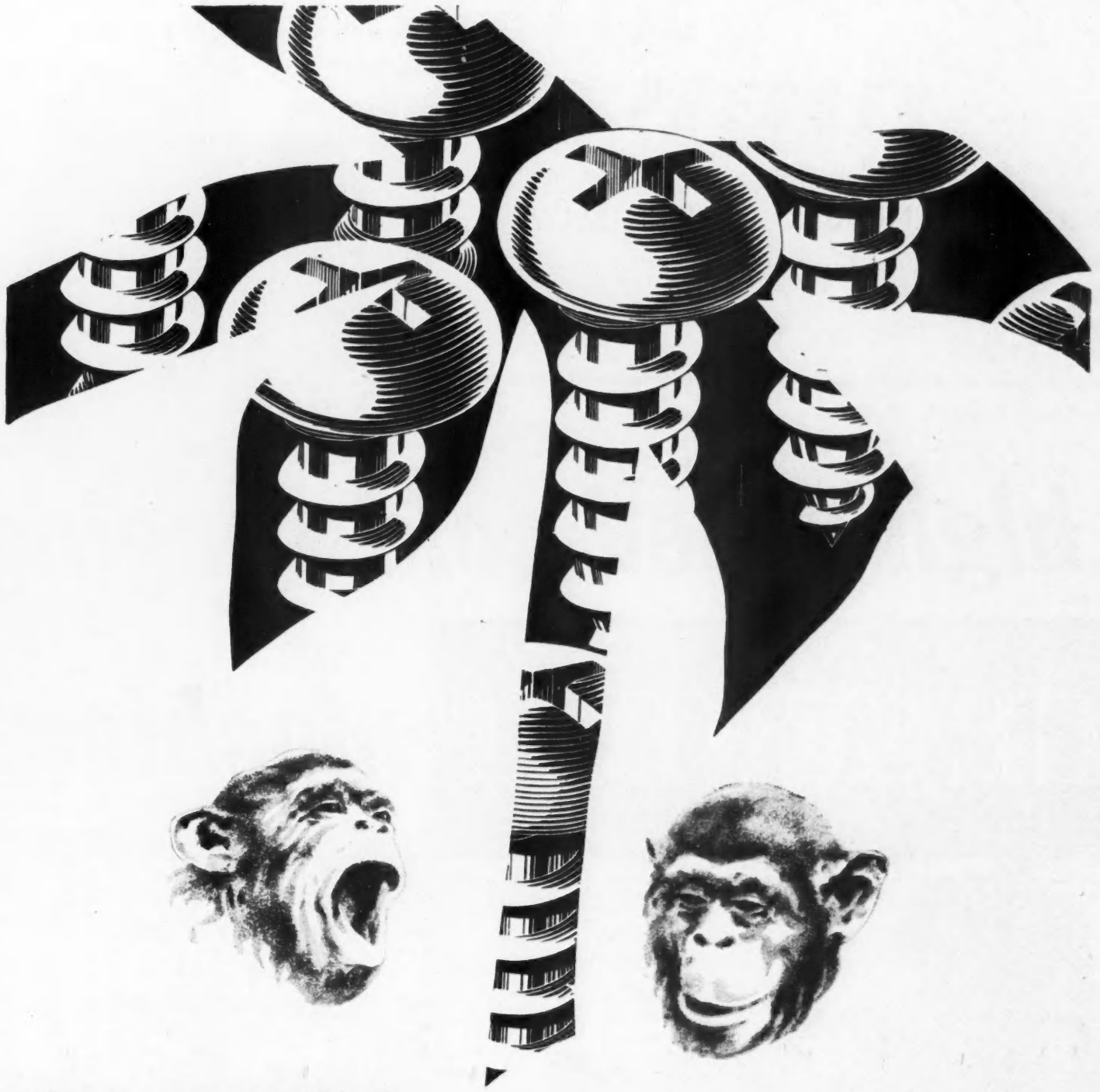

what, no nuts? . . .

Nuts to use nuts? Well, not exactly, but the fact that the Tapping Screw obviates the use of nuts is just one of its distinct advantages over the conventional Machine Screw. There's the saving in time to consider too. And cost. And there's no doubt whatever that the tapping screw makes for a better job all round. With its self-locating point the tapping screw forms its own thread thereby eliminating a separate and expensive tapping operation. Obviously it makes for easier assembly, is stronger, cheaper and faster. Safer too when the Phillips recessed head is specified, designed for power driving without damage to worker or job. You'll be well advised to change over to Tapping Screws. Nothing nuts about that !

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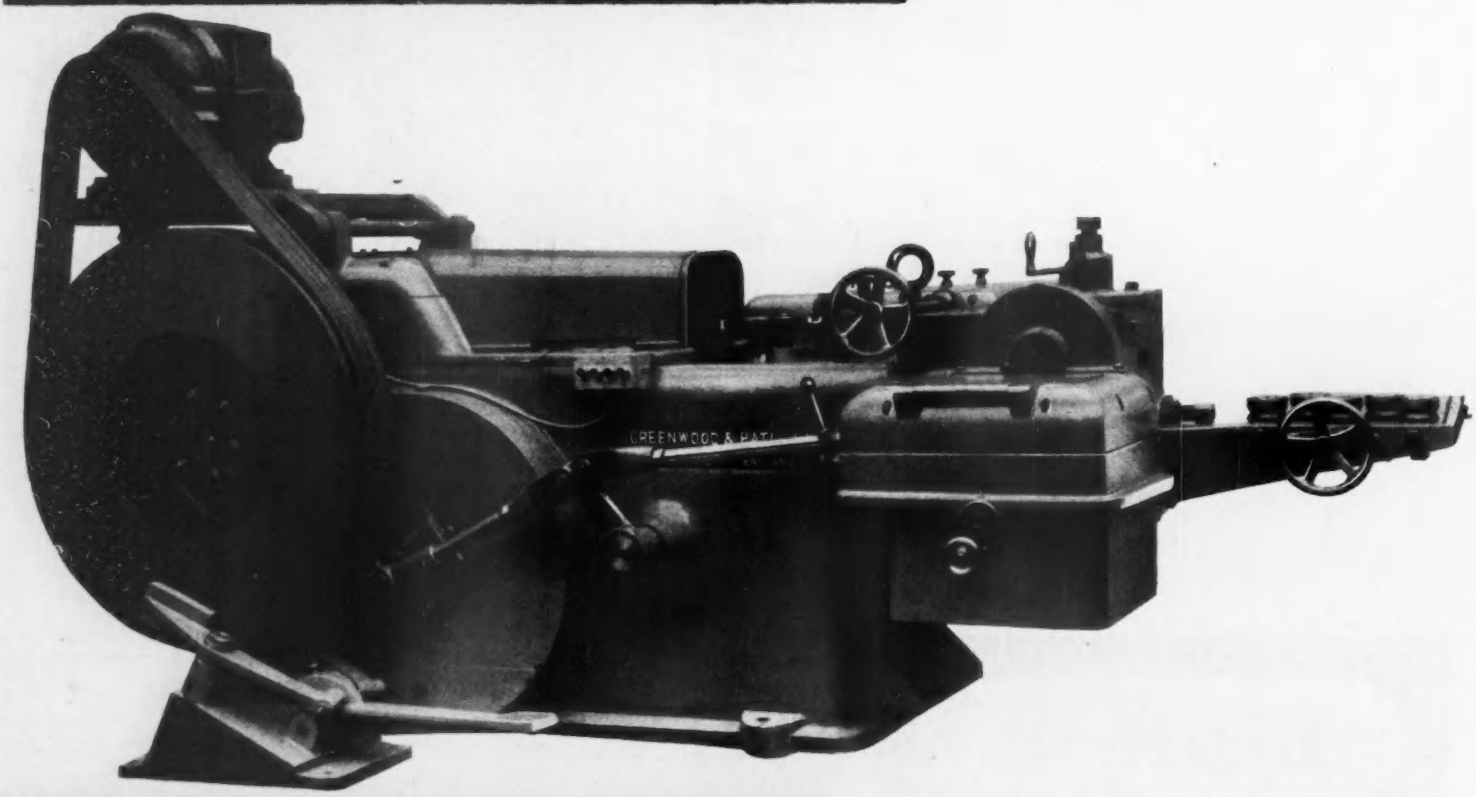

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T.4

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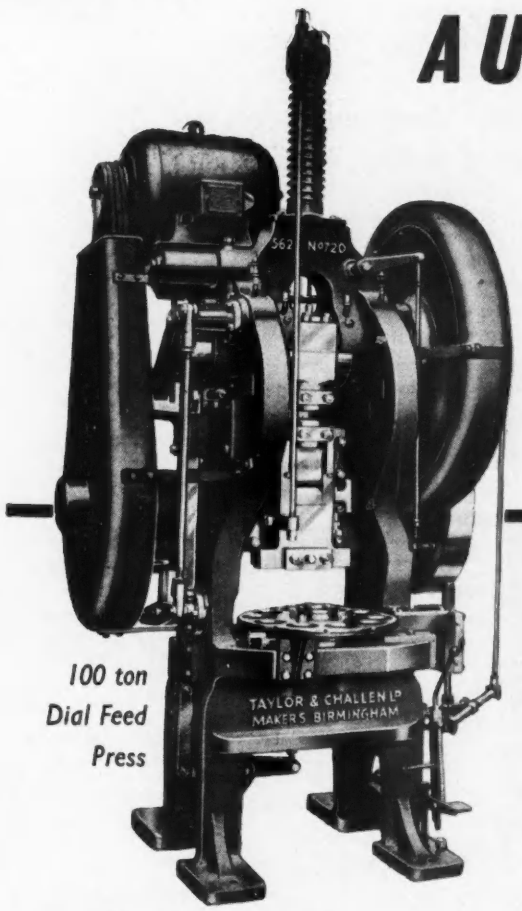
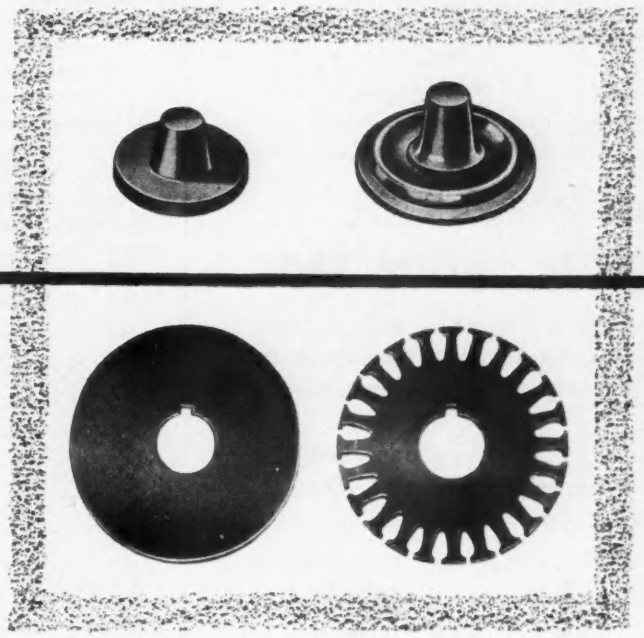


100 ton Dial Feed Press



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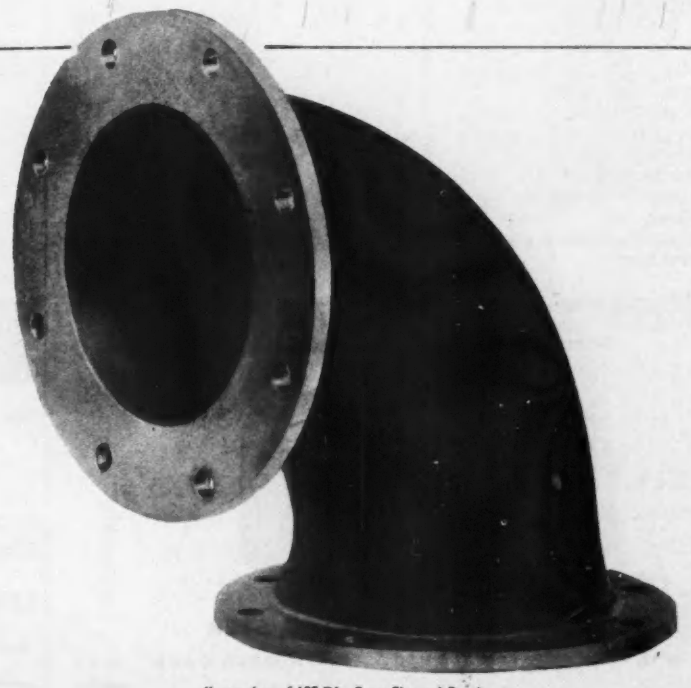

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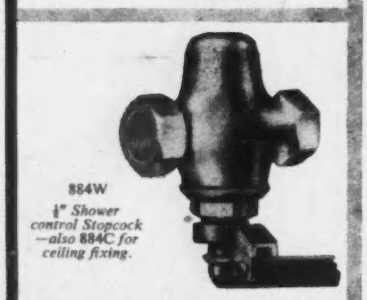

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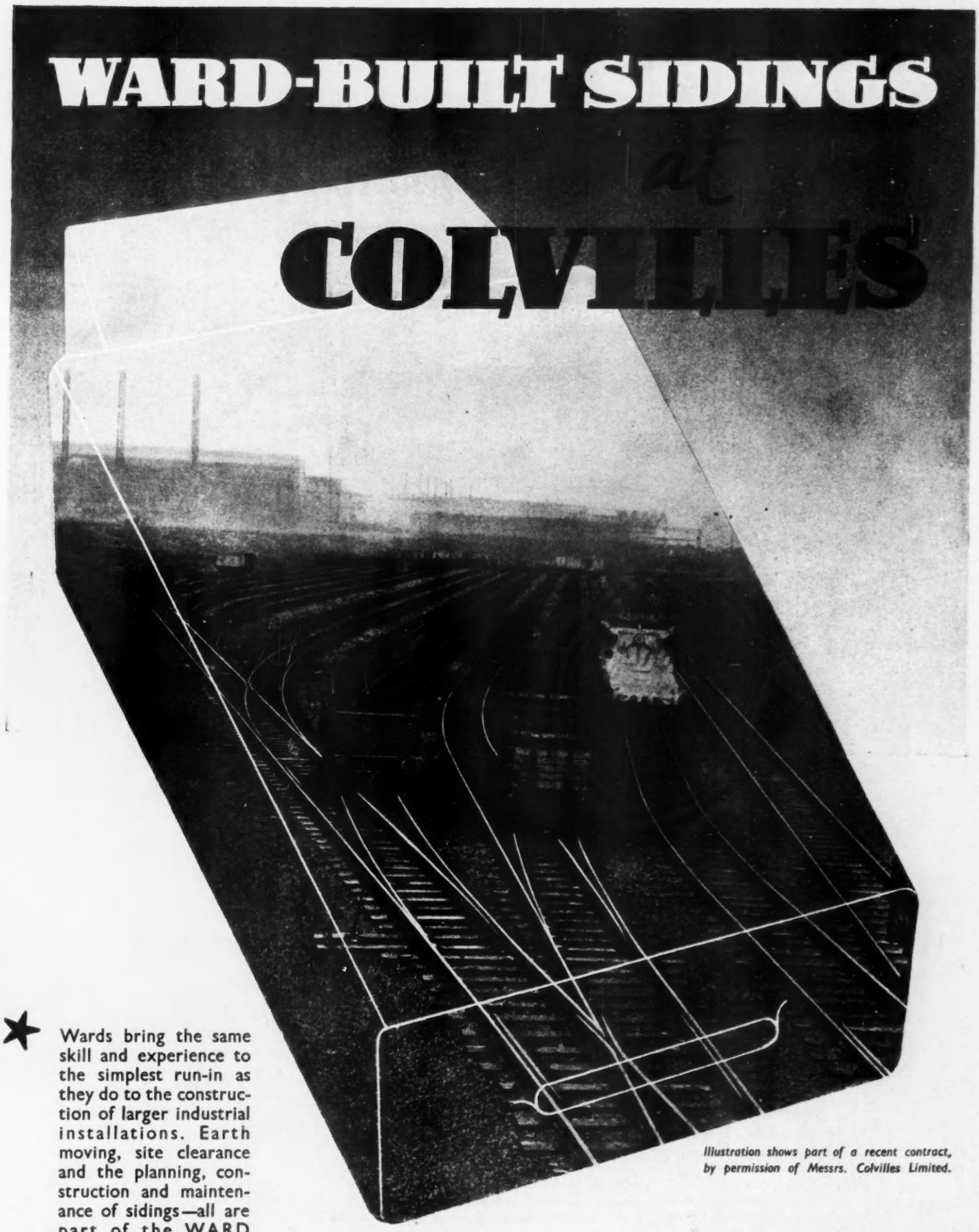

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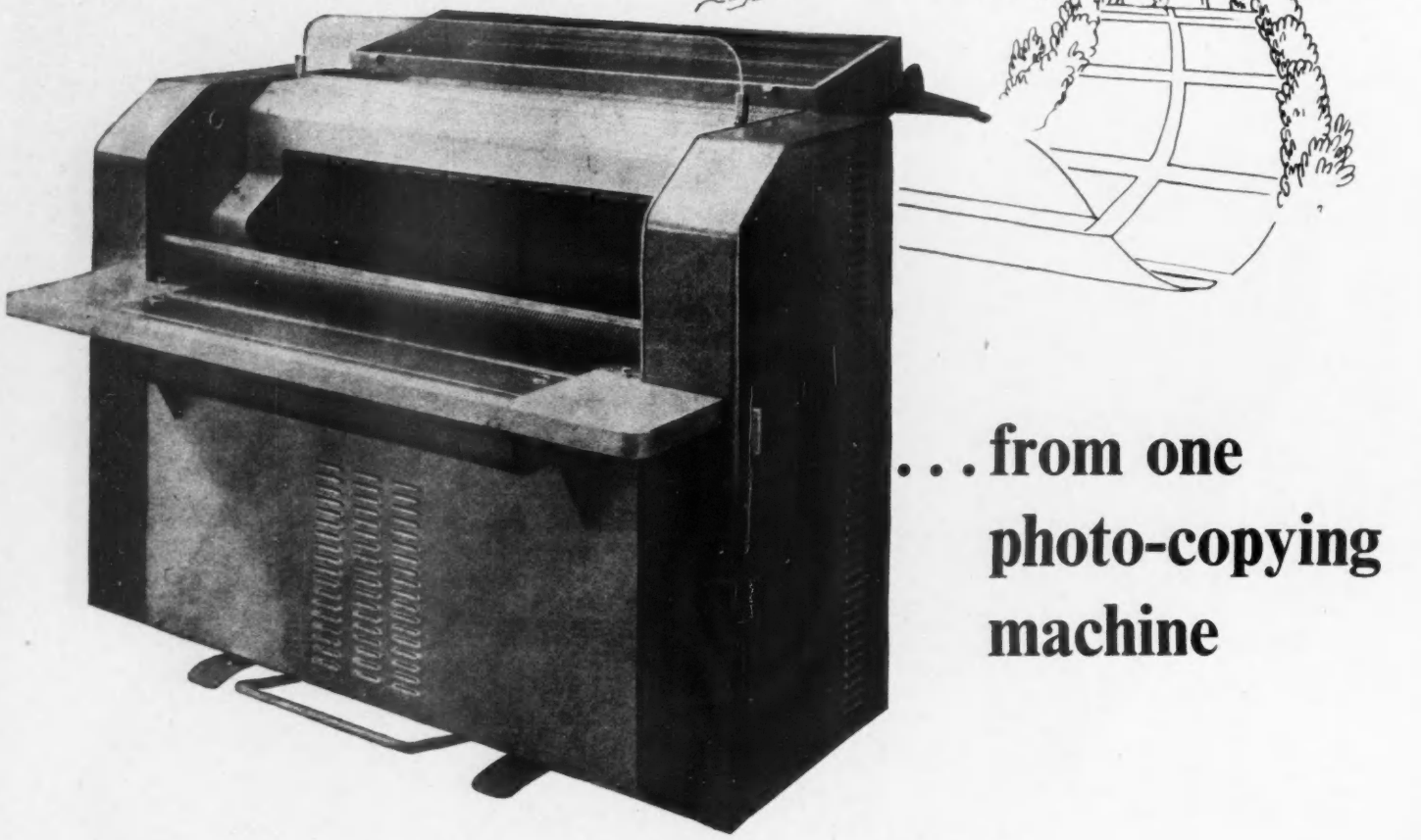

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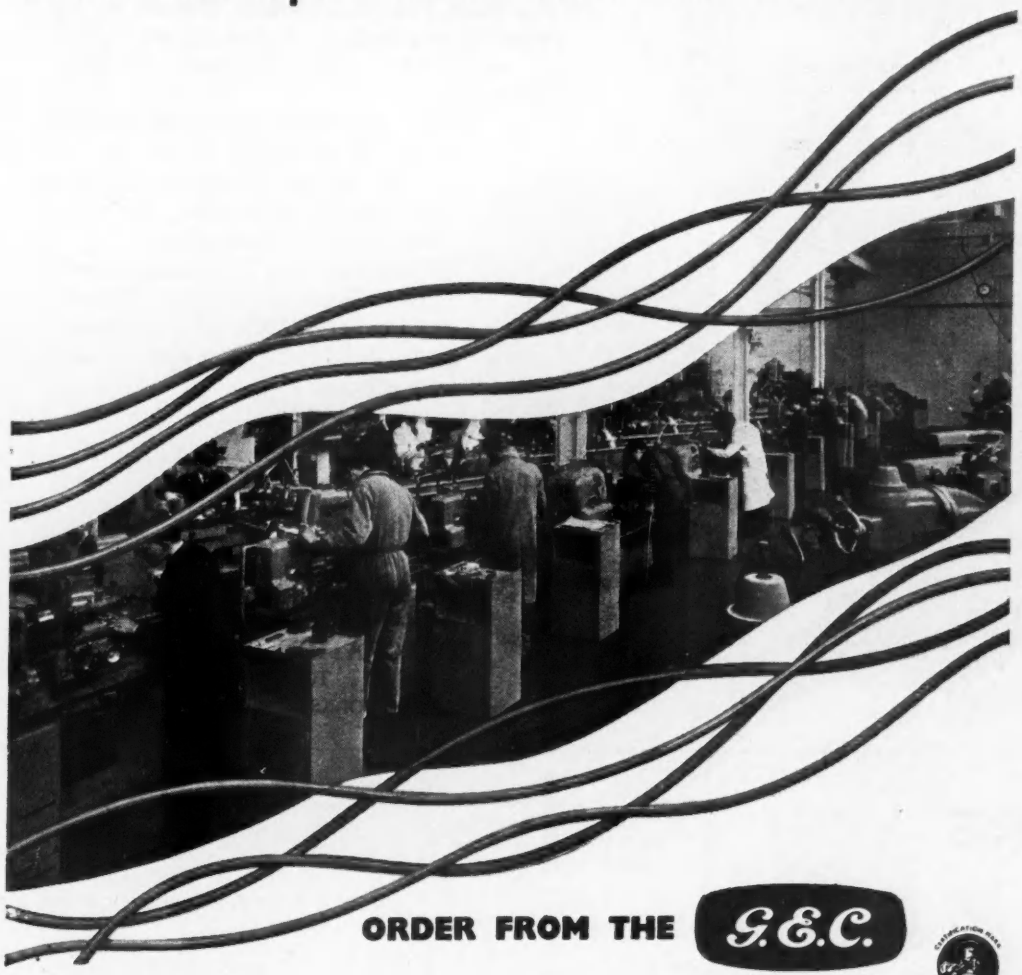

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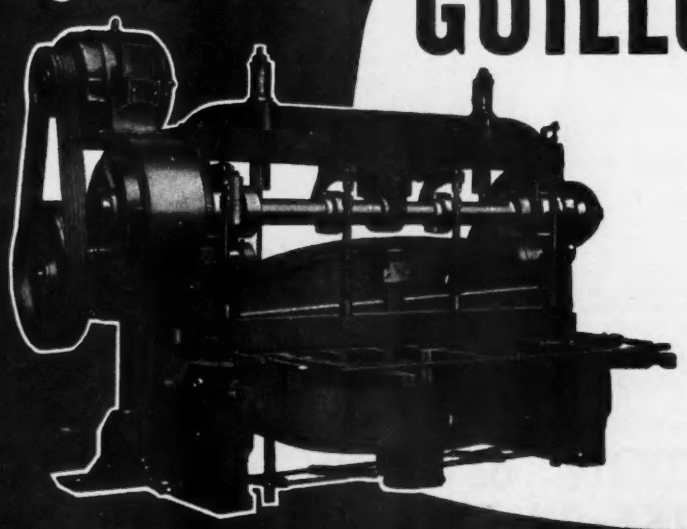

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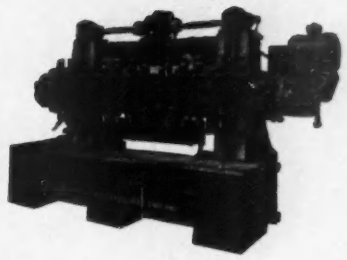
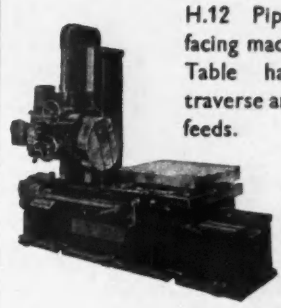


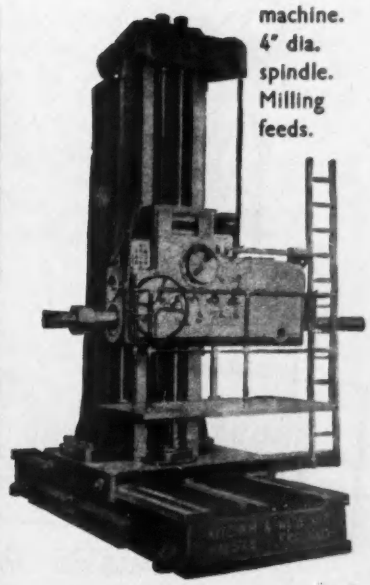
L.7 In line multiple spindle machine with automatic cycle.

E.24 4ft. to 6ft. Radial Drill. 3" Capacity. 12 speeds, 9 feeds, by single lever.



H.12 Pipe flange facing machine. Table has rapid traverse and power feeds.

H.6 Horizontal machine. 4" dia. spindle. Milling feeds.



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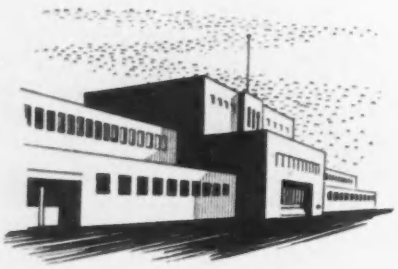

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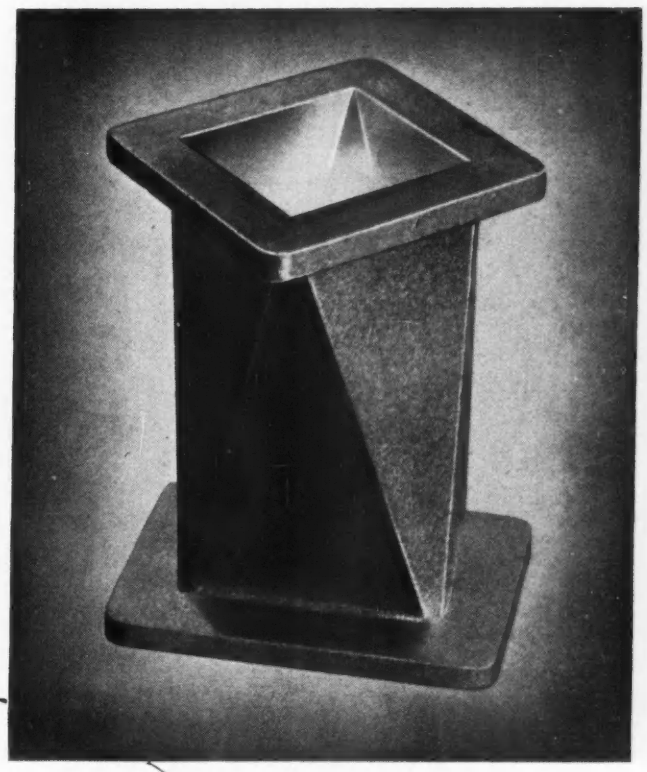

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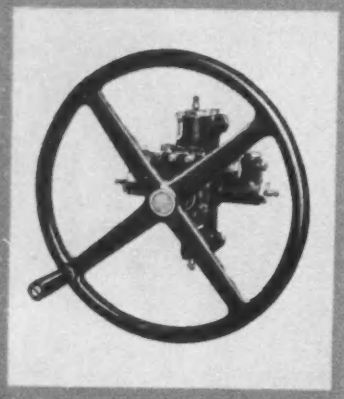
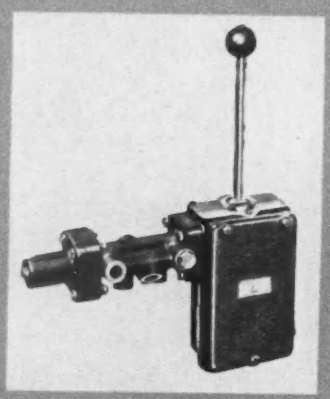
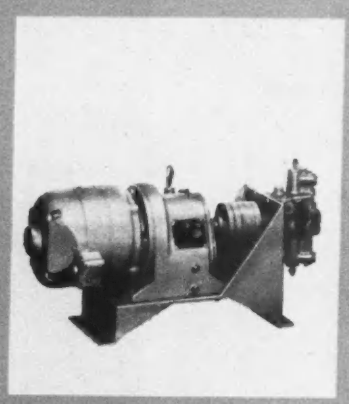
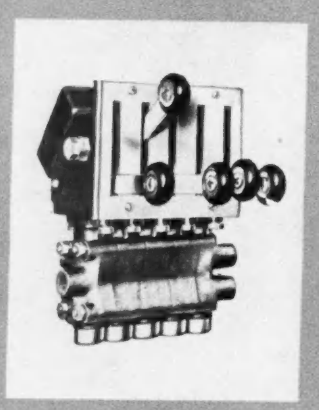
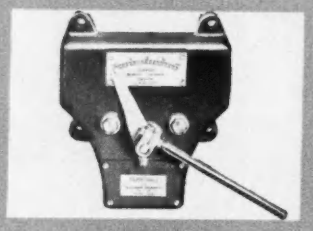
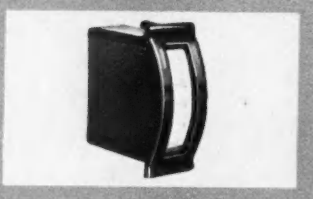
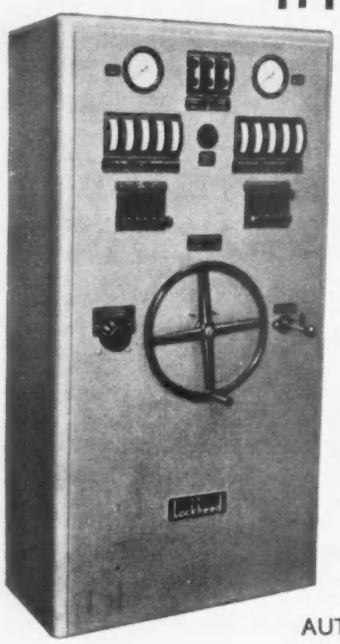







UNITS THAT HAVE MADE HYDRAULIC HISTORY



Lockheed specialized development on the problems of specific industries has led to the evolution of the many units which are ideal for their particular purposes.

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Lockheed

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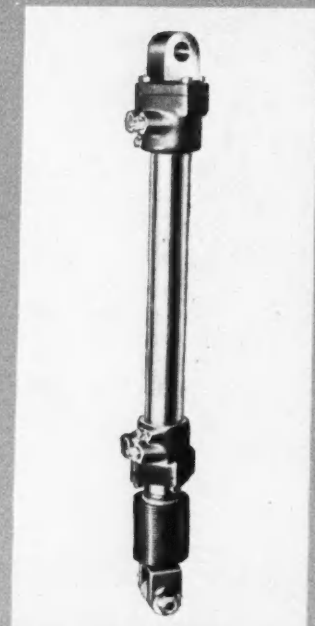
INDUSTRIAL HYDRAULICS



For further details please write for pamphlets, and kindly mention this journal.

COMPLETE INSTALLATIONS BRITISH MADE OR INDIVIDUAL UNITS

Stop Burning One in Ten!

Have a look at your power bill — and then consider your plant. Are you *sure* you are getting the most out of your transmission — or are inefficient drives frittering away the kilowatts which should be helping production?

As power costs increase efficiency matters more than ever — fit the only drive with a National Physical Laboratory Certificate confirming 98½% mechanical efficiency and get the power you pay for.

RENOLD high-efficiency drives cut your overheads

. . . Since 1947 electricity charges have almost doubled.
. . . Look at these figures from a typical factory :—

1947 £2·925 per 1,000 Units
1957 £4·9 per 1,000 Units

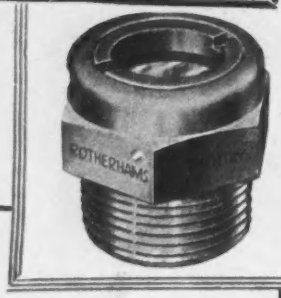
By making the most efficient use of power RENOLD CHAIN DRIVES are an effective counter to this cost spiral and can offset these and any future increases by as much as 10% — and go on doing so year after year.

RENOLD —*the FIRST name in precision chain*

RENOLD CHAINS LIMITED · MANCHESTER

E

OIL SIGHTS FOR MACHINE TOOLS



Accuracy to finest limits is automatically expected of every Rotherham product. The type of Oil Sight for Machine Tools illustrated serves to strengthen this confidence in Rotherham quality. This pattern is threaded ¾" B.S.P. Other sizes may be quoted for in production quantities. Remember us also for Brass T, Y, 4-Way and Elbow Pieces, Brass Taps of all kinds, Brass Grease Cups, Winkley Oilers, etc.

Rotherhams OF COVENTRY

ROTHERHAM & SONS LTD.
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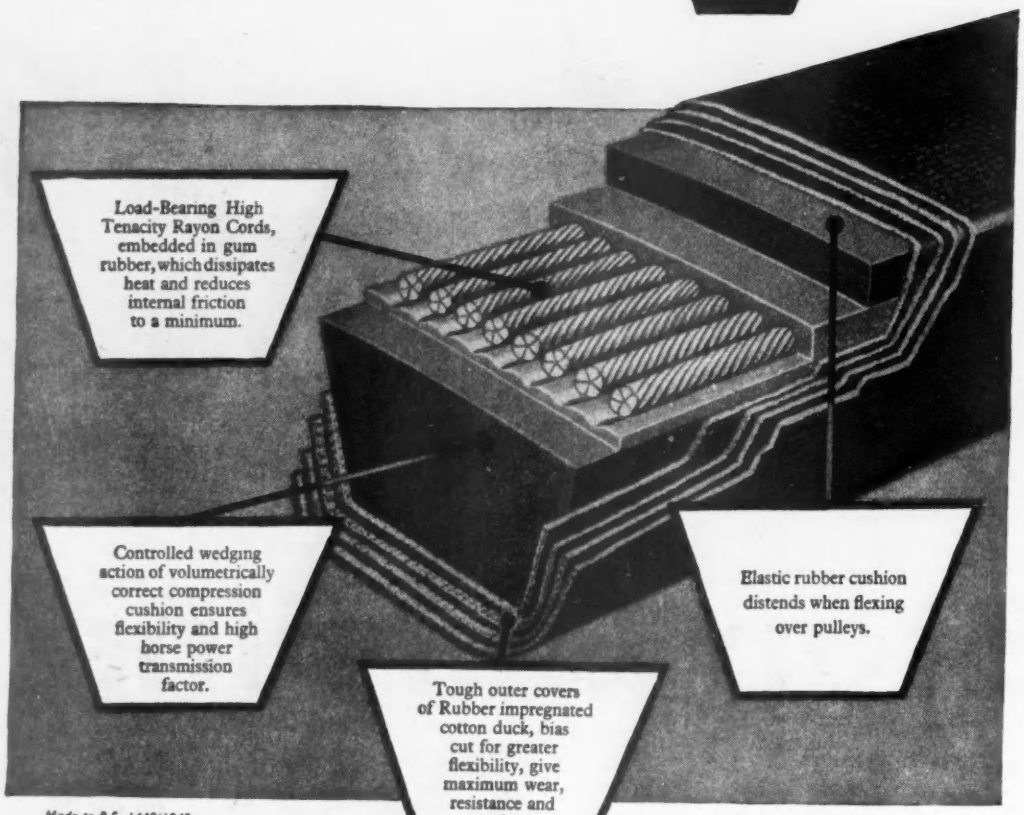
PRECISION MANUFACTURERS SINCE 1750

DESIGNED FROM THE INSIDE OUT


Load-Bearing High Tenacity Rayon Cords, embedded in gum rubber, which dissipates heat and reduces internal friction to a minimum.
Controlled wedging action of volumetrically correct compression cushion ensures flexibility and high horse power transmission factor.
Elastic rubber cushion distends when flexing over pulleys.
Tough outer covers of Rubber impregnated cotton duck, bias cut for greater flexibility, give maximum wear, resistance and grip.

Made to B.S. 1440/1948

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RAYON CORD V BELTS

TURNER BROTHERS ASBESTOS CO. LTD. ROCHDALE ENGLAND
A MEMBER OF THE TURNER & NEWALL ORGANISATION

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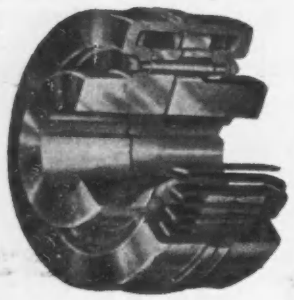

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COMPLETE COVERAGE

in dust collection and control plant

TRION ELECTRONIC AIR FILTERS

This filter, which also utilises the principle of electrical precipitation, removes airborne pollutants of sub-micron size. It is essentially designed for those instances where even low concentrations of particulate matter may have serious consequences. During the past ten years over 10,000 units have been installed in the U.S.A. and on the Continent.

HOLMES-ELEX ELECTRICAL PRECIPITATORS

Used for the removal of micron and sub-micron liquid and solid particulate matter from all types of carrier gases. More than 1,150 irrigated and dry precipitators, of all types, have been installed by ourselves and our Associates in all parts of the world.

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This comprehensive range of dust collection and control equipment is applicable to a wide range of problems involving liquid and solid particles sized above three to four microns. Invented in the U.S.A. some thirty years ago this system embraces patented hoods, high efficiency collectors, cupola spark arrestors, velocitraps and various designs of settling tanks.

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Although only recently introduced into this Country, more than 525 of these inexpensive cyclone collectors have been in operation for many years on the Continent. They represent an economical and efficient solution to the collection of particles in the higher size ranges.

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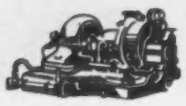

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Over 50 years' experience.
Hundreds in hand—thousands in service.

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Air, Gas, and Refrigerating.
The widest range in the British Empire — made to suit your requirements.
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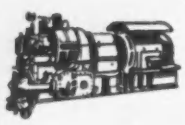

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Engine driven up to 340 KW.
Scores in hand, hundreds in service.

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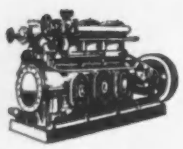

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Made to measure for special duties.

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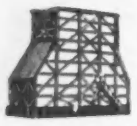

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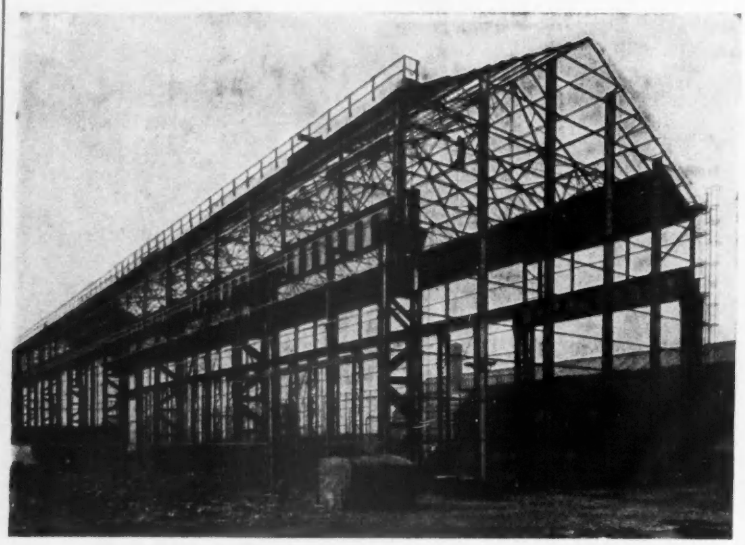

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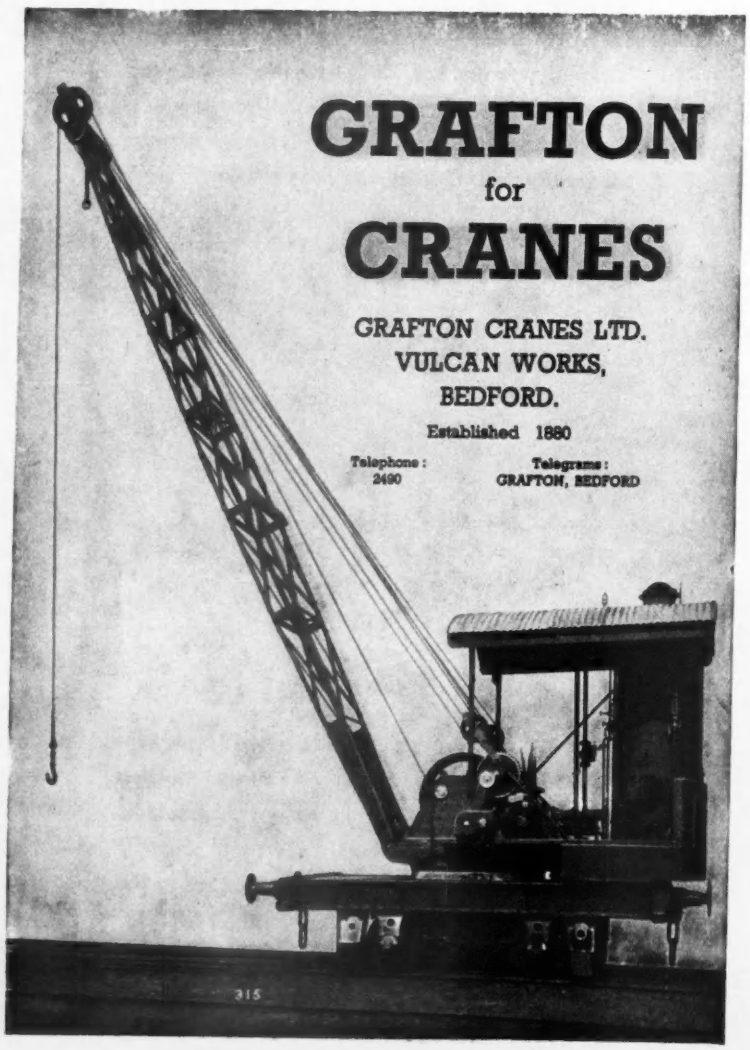
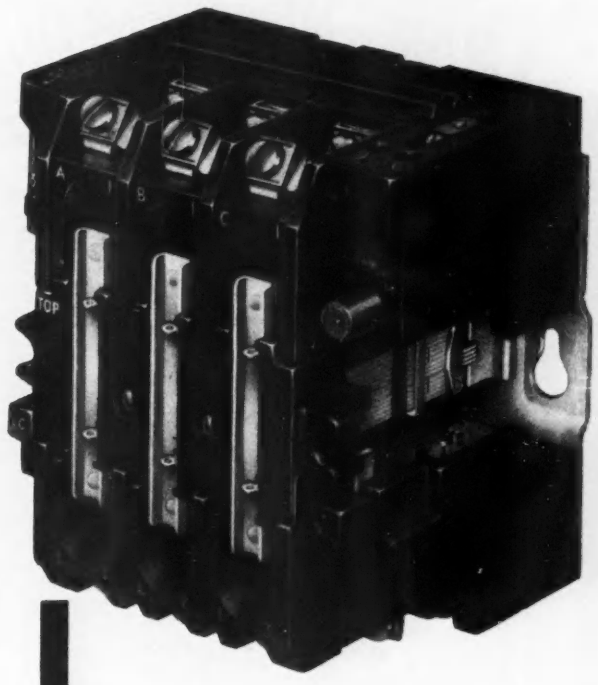


positive proof of long life



. . . actual motor-load life tests!

The life of starter contacts should not be forecast from their loss of weight after a few thousand operations because the rate of wear can, of course, vary considerably. The most reliable method is to use the starter tor *stopping and starting a motor repeatedly until the contacts are burnt away.*

Such tests are now proceeding on Crabtree Type B-15 starters taken at random from warehouse stocks. To date, the starters have given the following operations (start and stop) without change of contacts or other components:

(a) Controlling a 5 h.p. motor: 2,750,000 operations;

(b) Controlling a 1 h.p. motor: 2,750,000 operations.

these tests are continuing

facts about Crabtree Type B-15 starters

Crabtree

Type B-15 starters

1. *The first and still the leading starter of "unit" construction.*
2. *Wide range of adjustment for full-load current variations.*
3. *Built-in, on-load, interlocked isolating switch unit can be added. Fuses to B.S.88: 1952, Cat. 440 AC4 are optional.*
4. *Enclosures for general purpose and heavy industrial use.*
5. *Frontal access to all terminals and components.*
6. *Built-in trip signalling.*
7. *Single-screw fixing for additional auxiliary contacts.*
8. *Rating. Motor-load: 15 amp. (10 h.p. 415 volts. 3 phase). Non-inductive load: 25 amp. per pole.*

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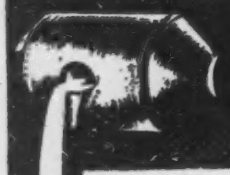

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Stillage for 1,000lb. cable drums for use with fork and hand pallet trucks.

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We are producing new designs nearly every day—many of them designed to meet customers' special needs. Here are eight of the latest, one of which may be just what you are looking for. Companies representing nearly seventy different industries have found the answer to their mechanical handling or storage problems in M.G.K. Pallets. The same service is available to you—M.G.K. have the answer to YOUR Palletisation problems.

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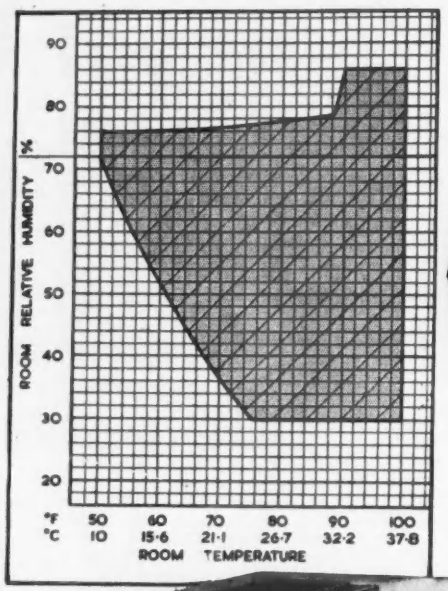
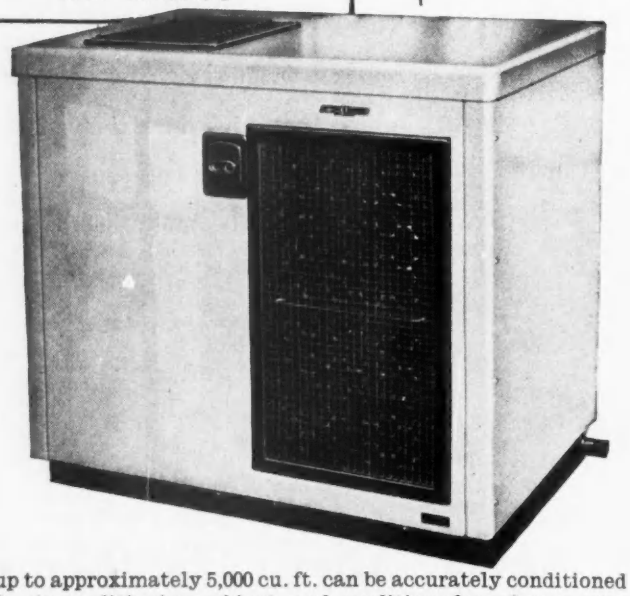


to any conditions within this area



Rooms up to approximately 5,000 cu. ft. can be accurately conditioned with this air-conditioning cabinet, and conditions have been maintained within ±0.5F. and 0.75% relative humidity. The cabinet is provided with an air outlet raised above bench level. Larger units are available for special applications.

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Other products include:—
Automatic temperature and humidity controllers for buildings and factories; complete process automatic control and instrumentation.
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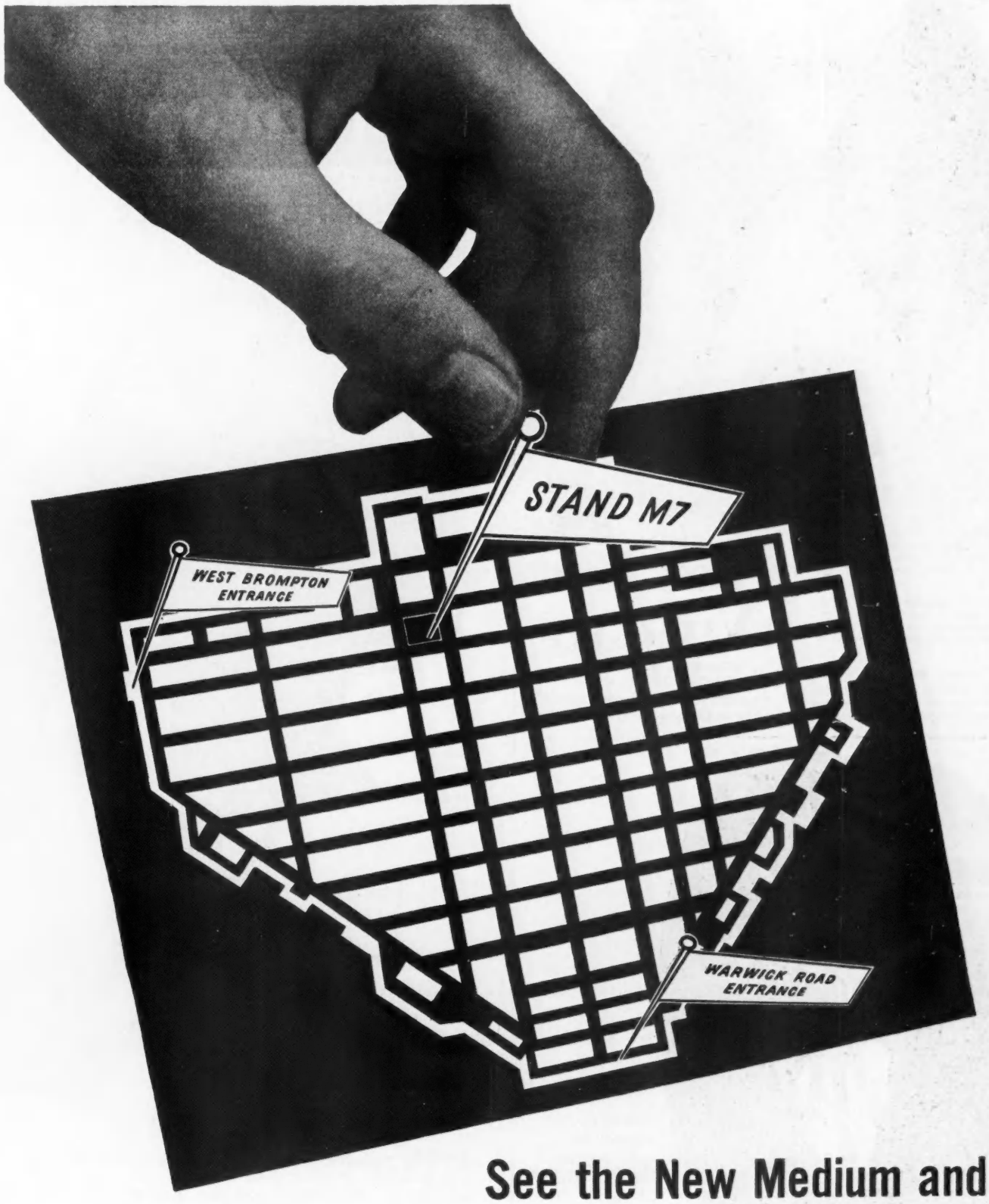

See the New Medium and High Voltage Switchgear

ON STAND M7

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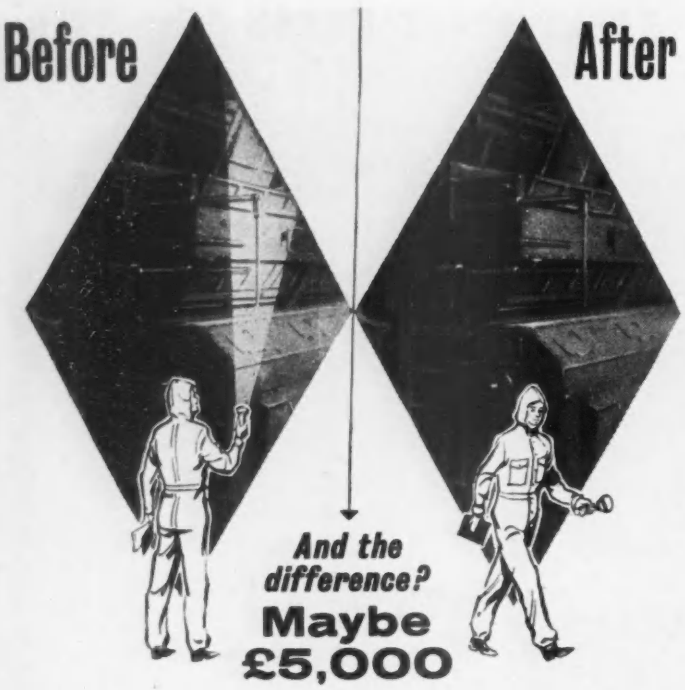
Continuing a Tradition

785



How? Faulty water gauges were spotted, and an accident costing £5,000 or more has been prevented.

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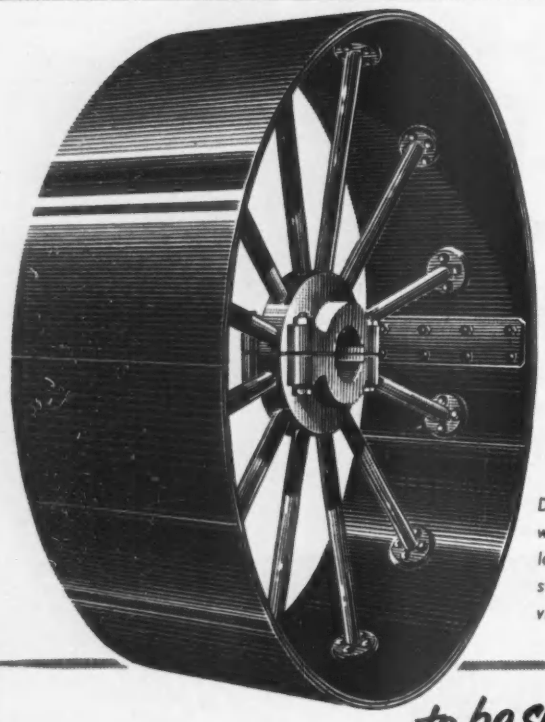

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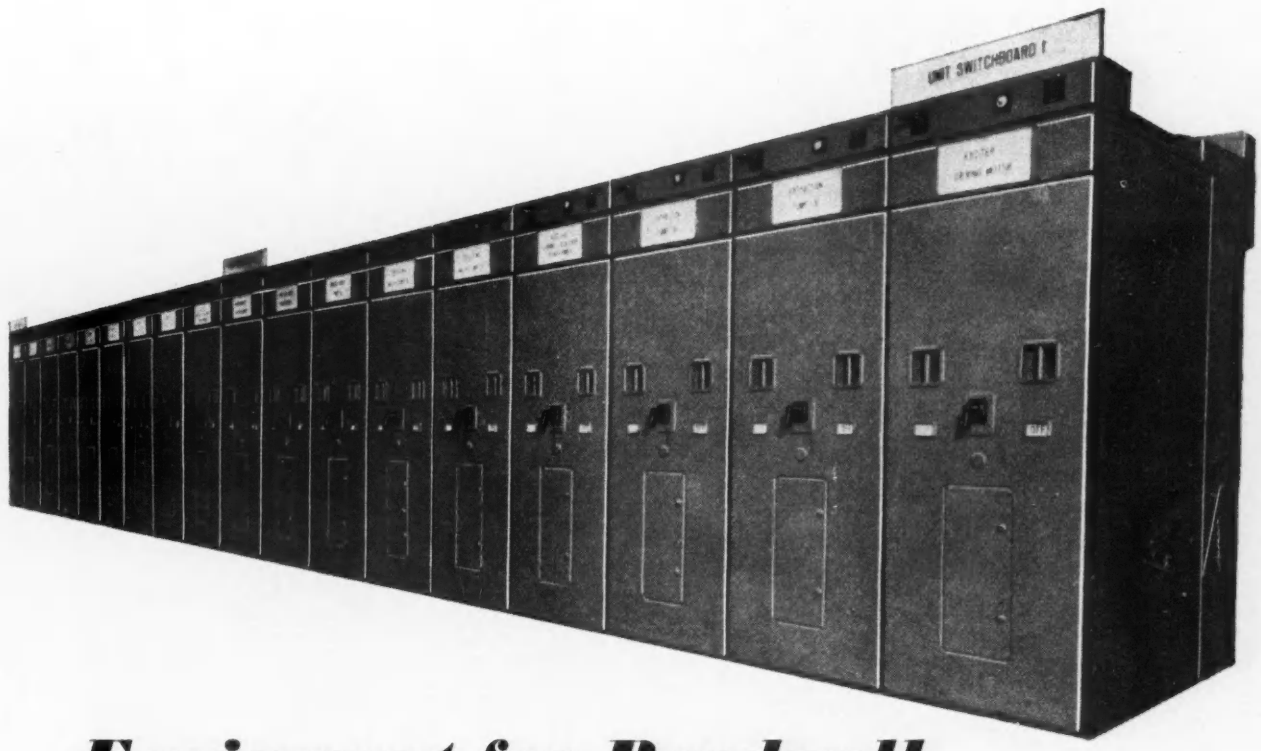

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All the switchgear comprising the main 132-kV air-blast circuit-breakers, 6·6-kV, 3·3-kV, and 415-volt air-break equipment for auxiliary supplies, together with its associated control apparatus for Bradwell Nuclear Power Station is being supplied by Reyrolle who are responsible also for the reactor control-rod heads, the fission-products detection equipment, and the machining of the graphite blocks.

Reyrolle specialists in switchgear and control-apparatus

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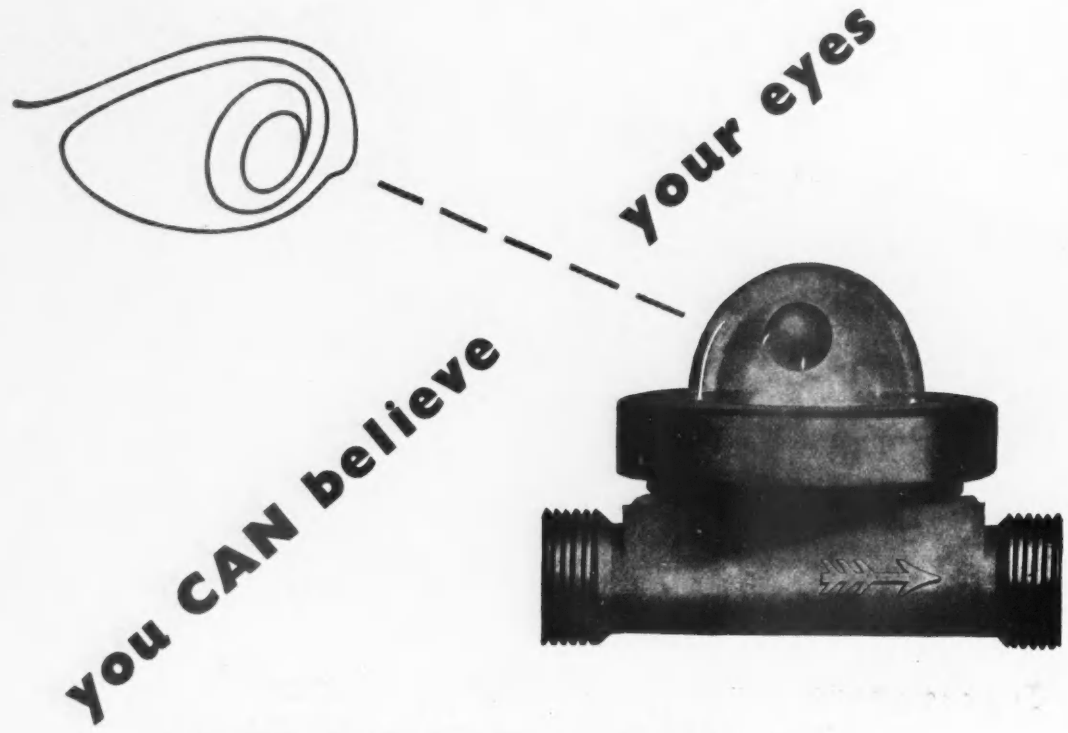

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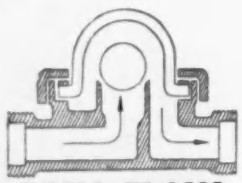
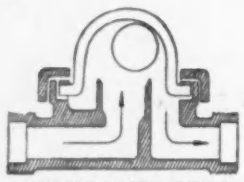
Where circulating water systems are concerned, for radiators, condensers, liquid vats, oil coolers, radio transmitting equipment and the like, a 'SHOFLO' Indicator is the perfect answer when you've got to tell *at first sight* whether the coolant is flowing or not.



LOW FLOW

A whirling ball under the toughened glass dome indicates passage of clear or translucent liquids at flows as low as 4 g.p.h., pressures up to 100 p.s.i. Standard casing is aluminium bronze for ½" sizes, gunmetal for 1½" sizes; other metals for alkaline or acidic fluids.



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Available in two sizes: Nominal ½" and 1½" bores for flows up to 2,000 g.p.h. ½" size also made with right angle inlet and outlet.

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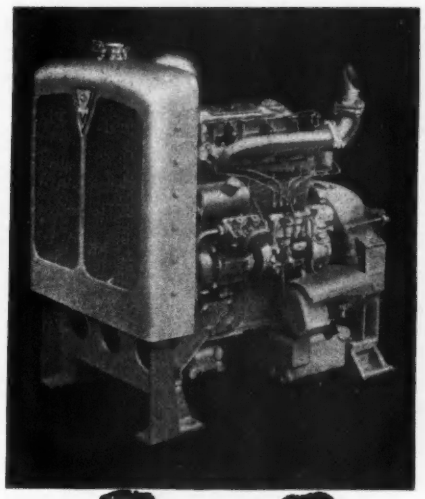

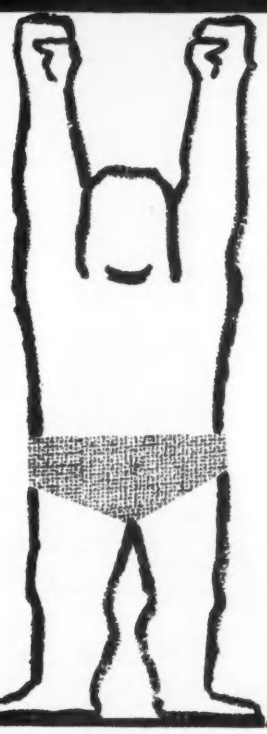

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This new 4-cyl. Industrial Diesel Engine has been designed by A.E.C. and Maudslay for earth moving and industrial equipment in which ample power is provided by an engine with a maximum output of 75 b.h.p. and a continuous rating of 50 b.h.p. It has all the features of the existing range, top performance, reliability in the severest working conditions, consistent operating economy — and interchangeability of working parts. For maximum usable power at the most economical r.p.m. in 50-150 b.h.p. industrial diesels, it will pay you to investigate the well-proved A.E.C. range, *including:*

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	60 LB. PER SQ. IN.	1 TO 380 CU. FT. PER MIN.
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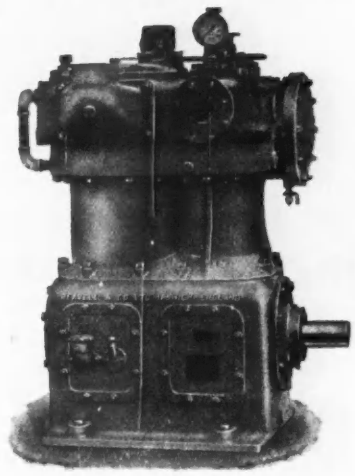

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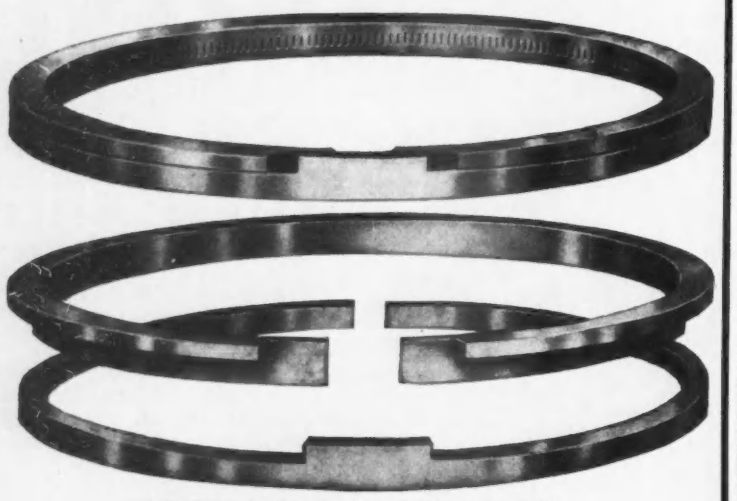

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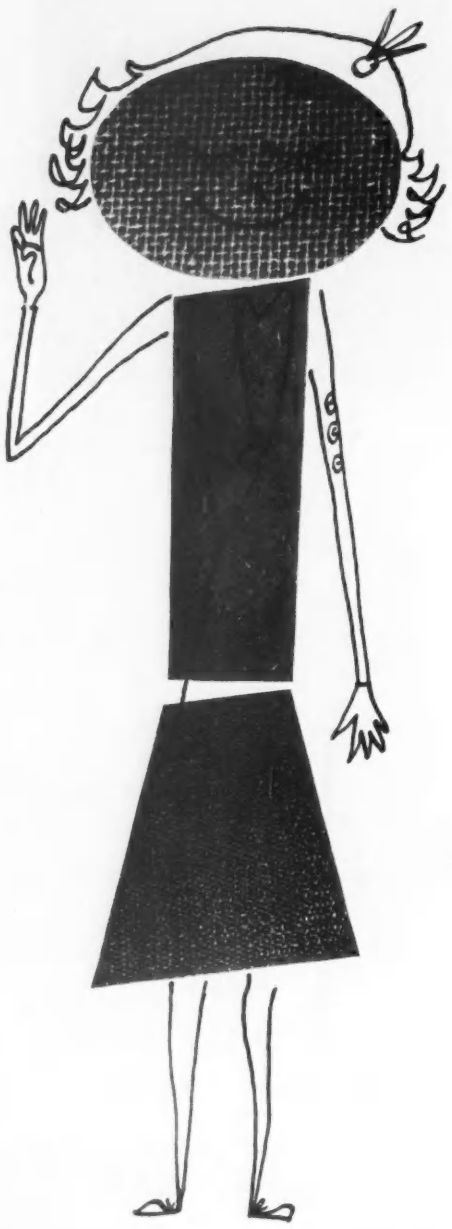

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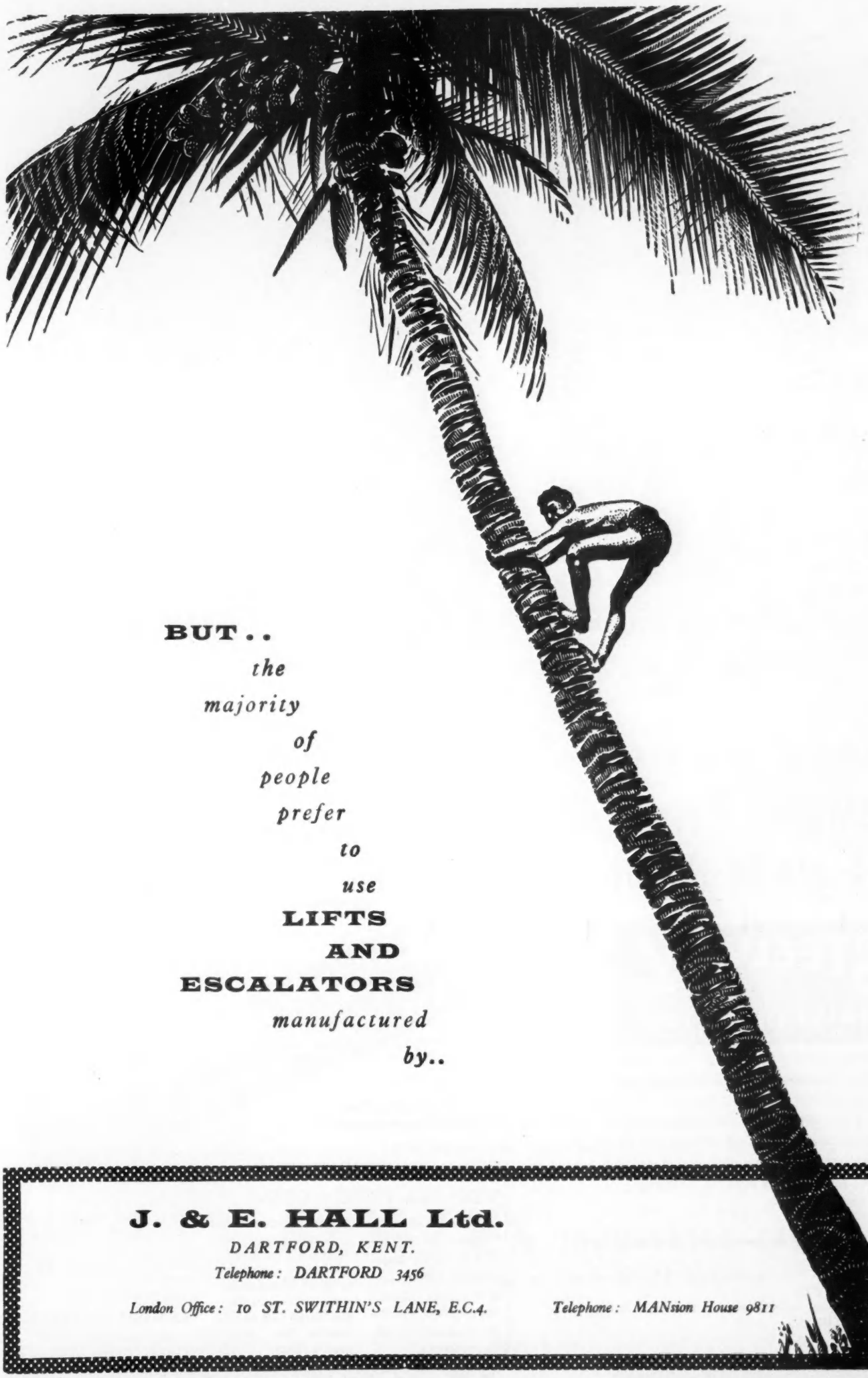

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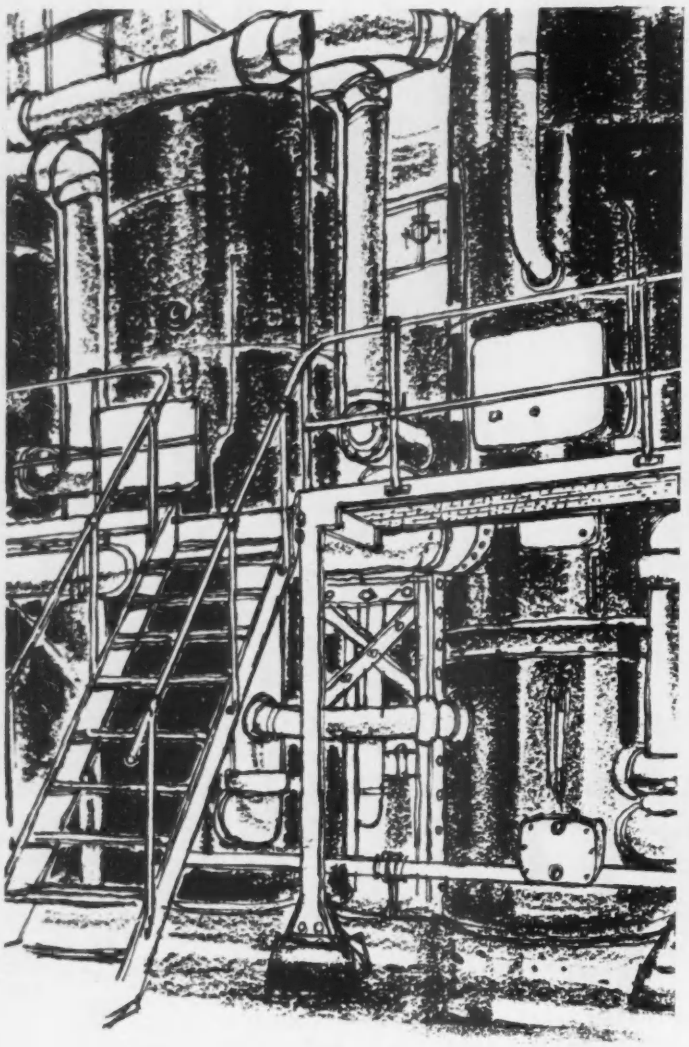

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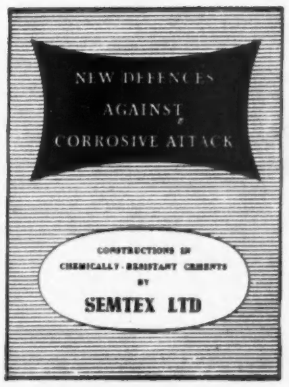

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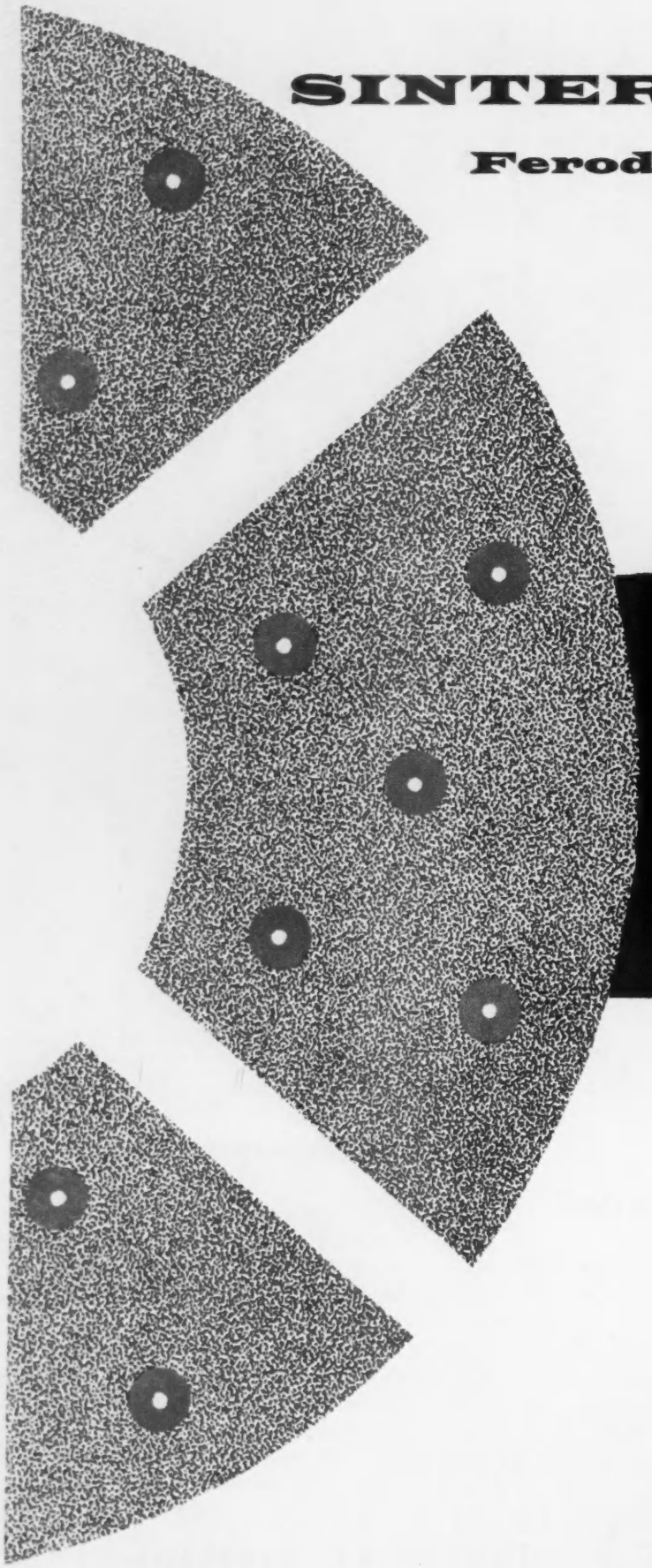

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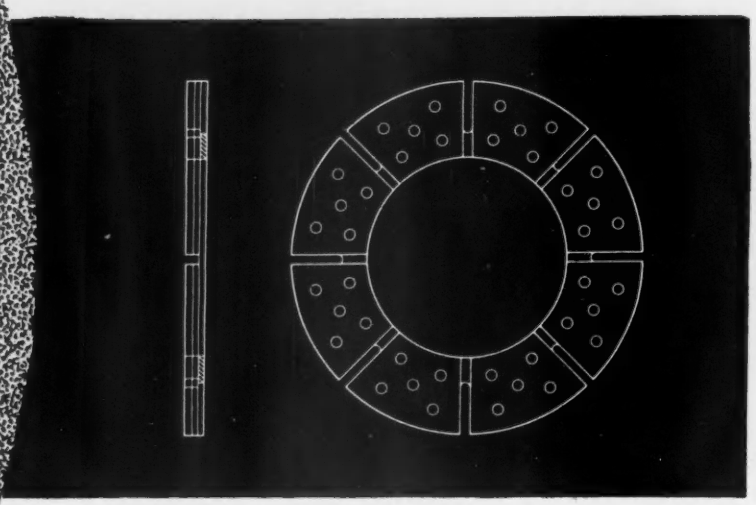

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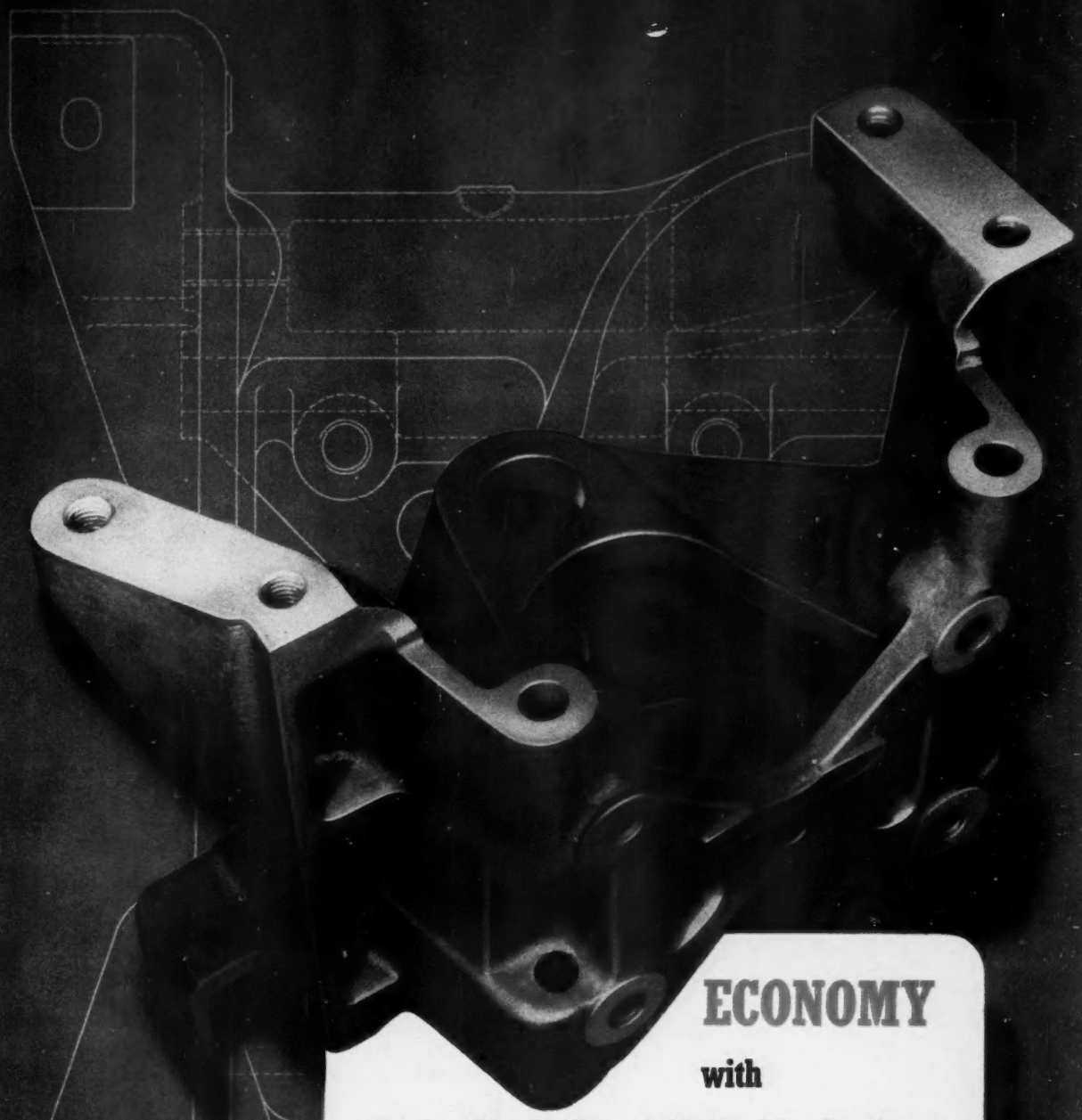

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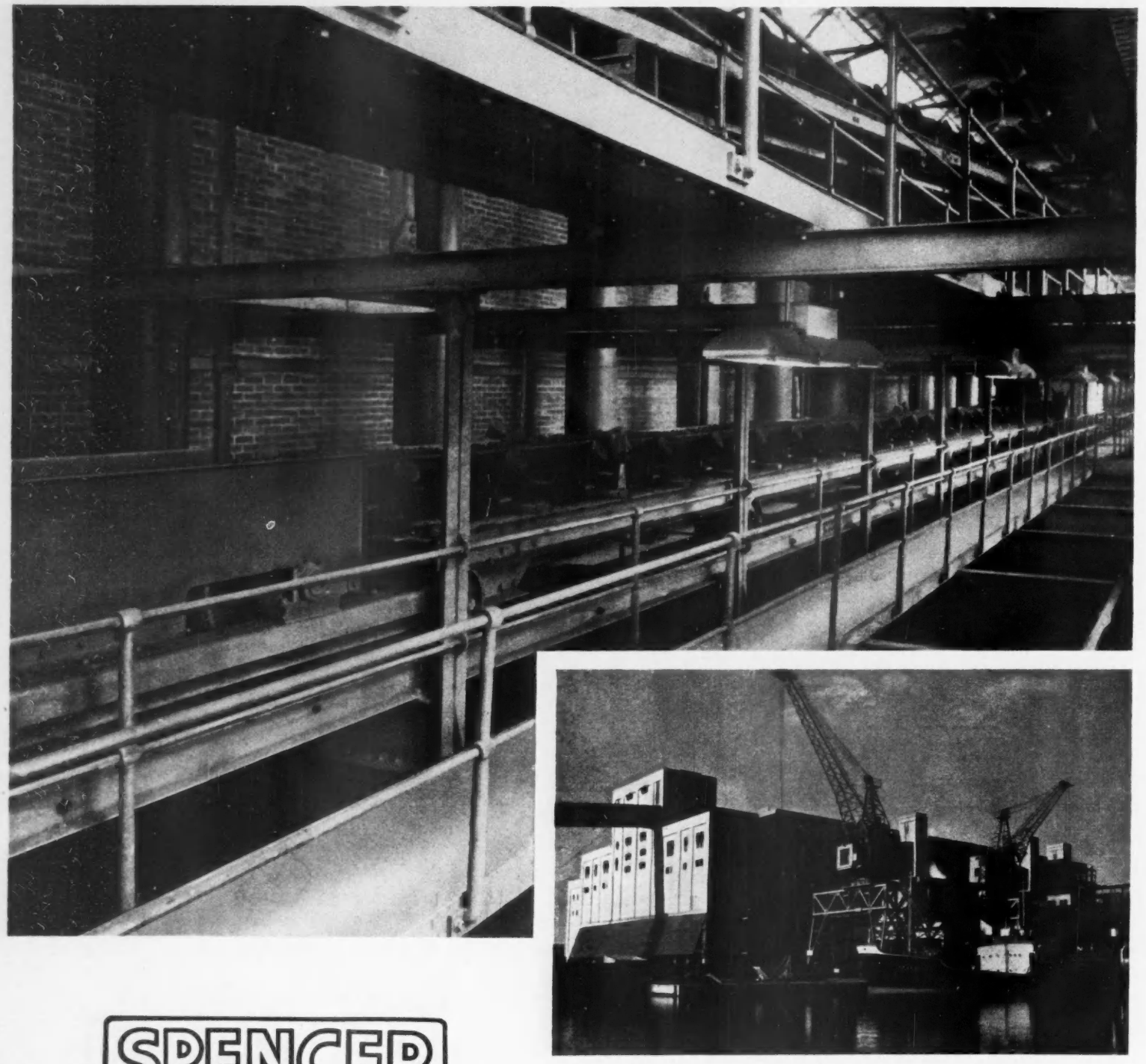

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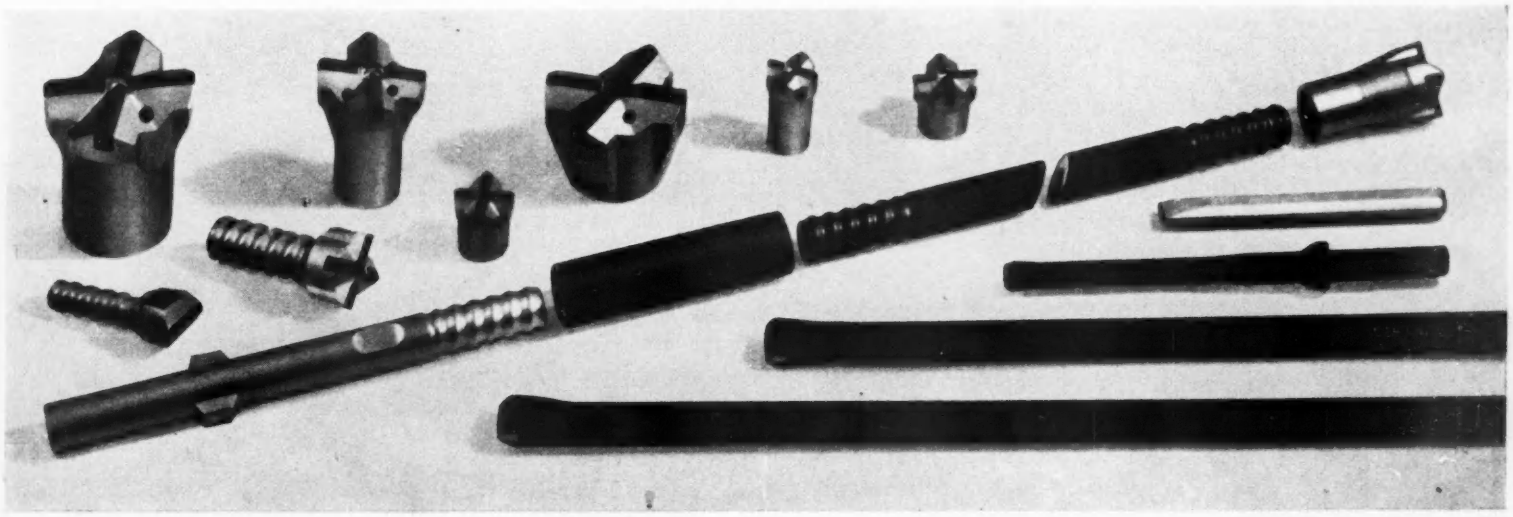

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Flexible drill steels	2′7″-31′6″

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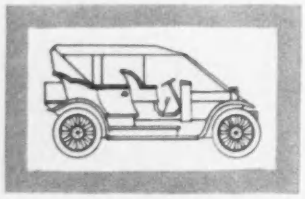

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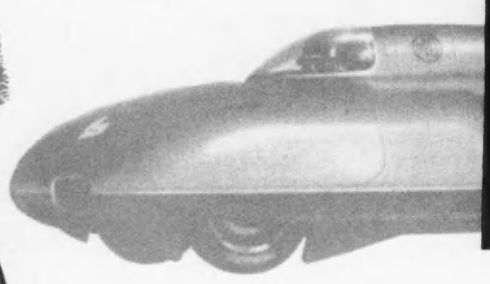

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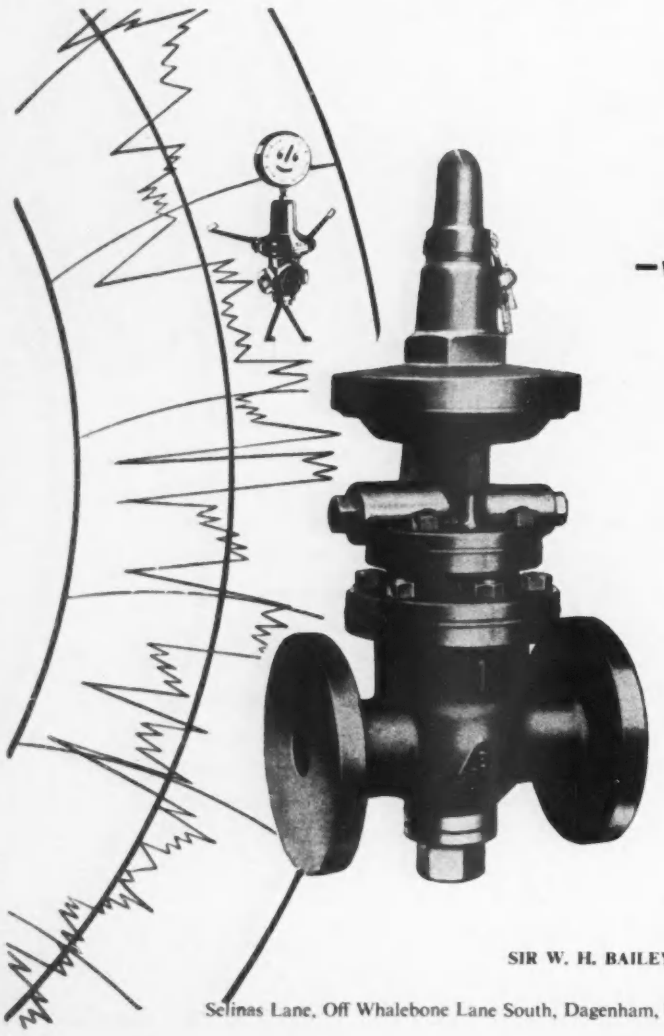

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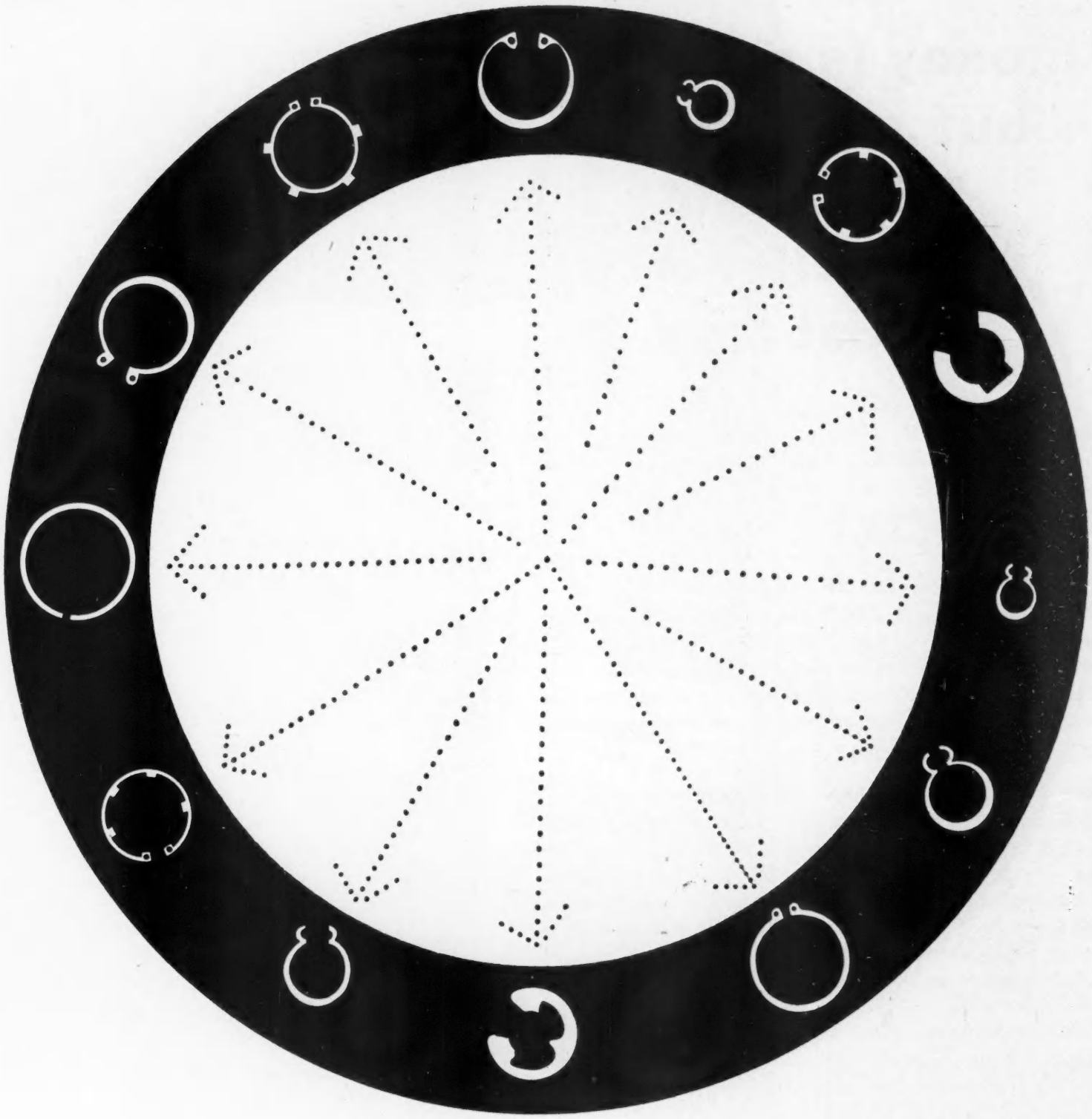

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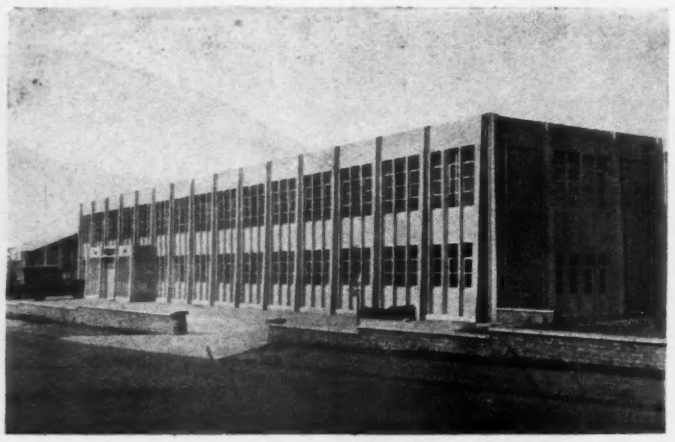

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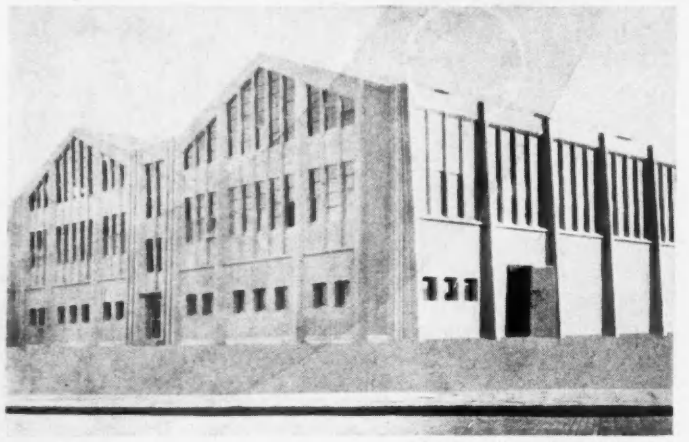

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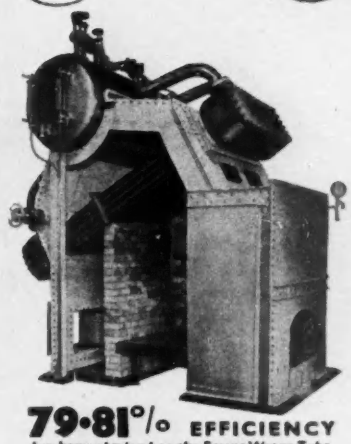

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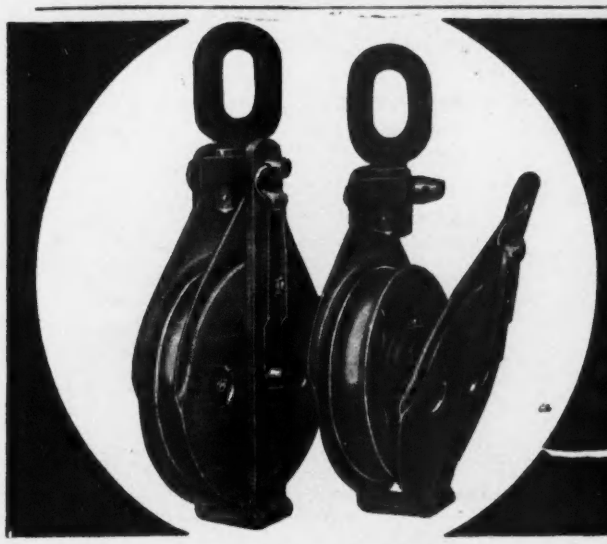

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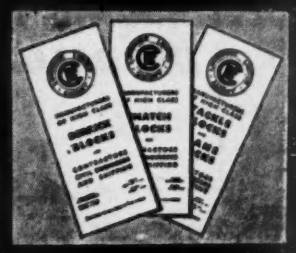

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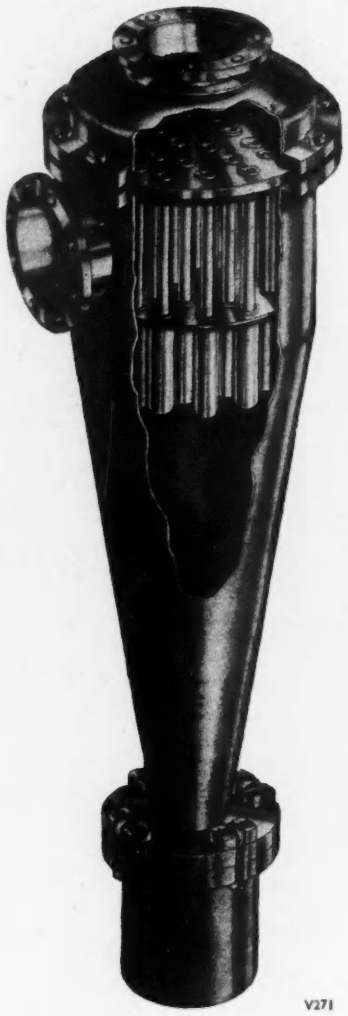

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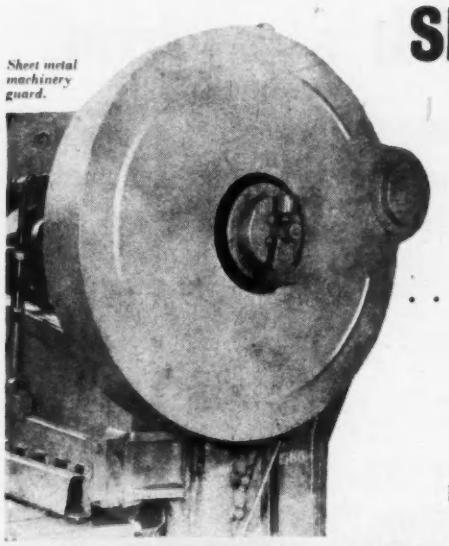

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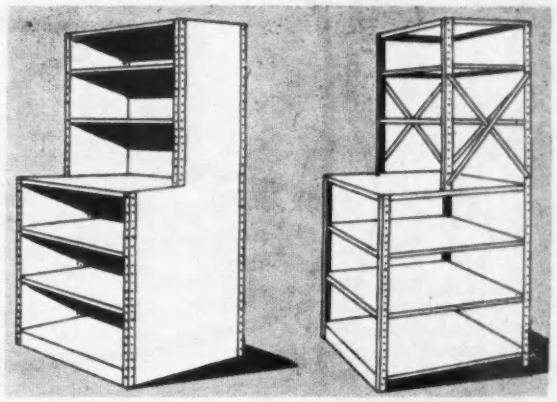

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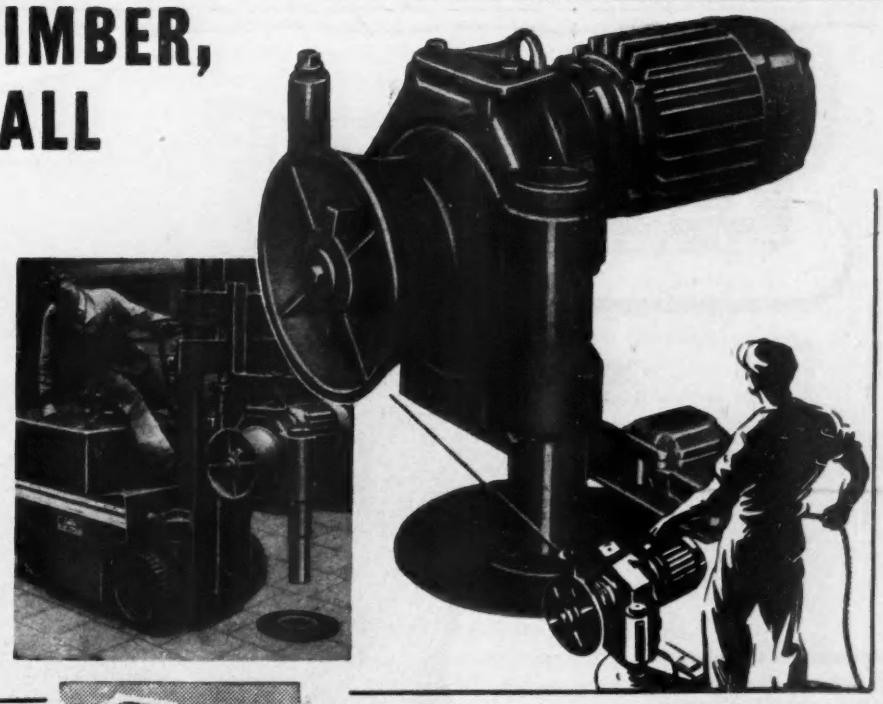

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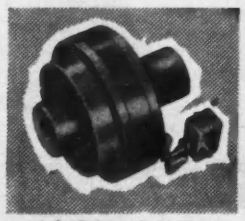

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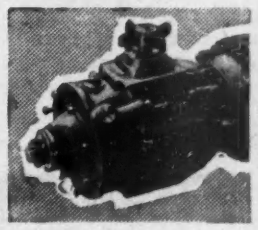

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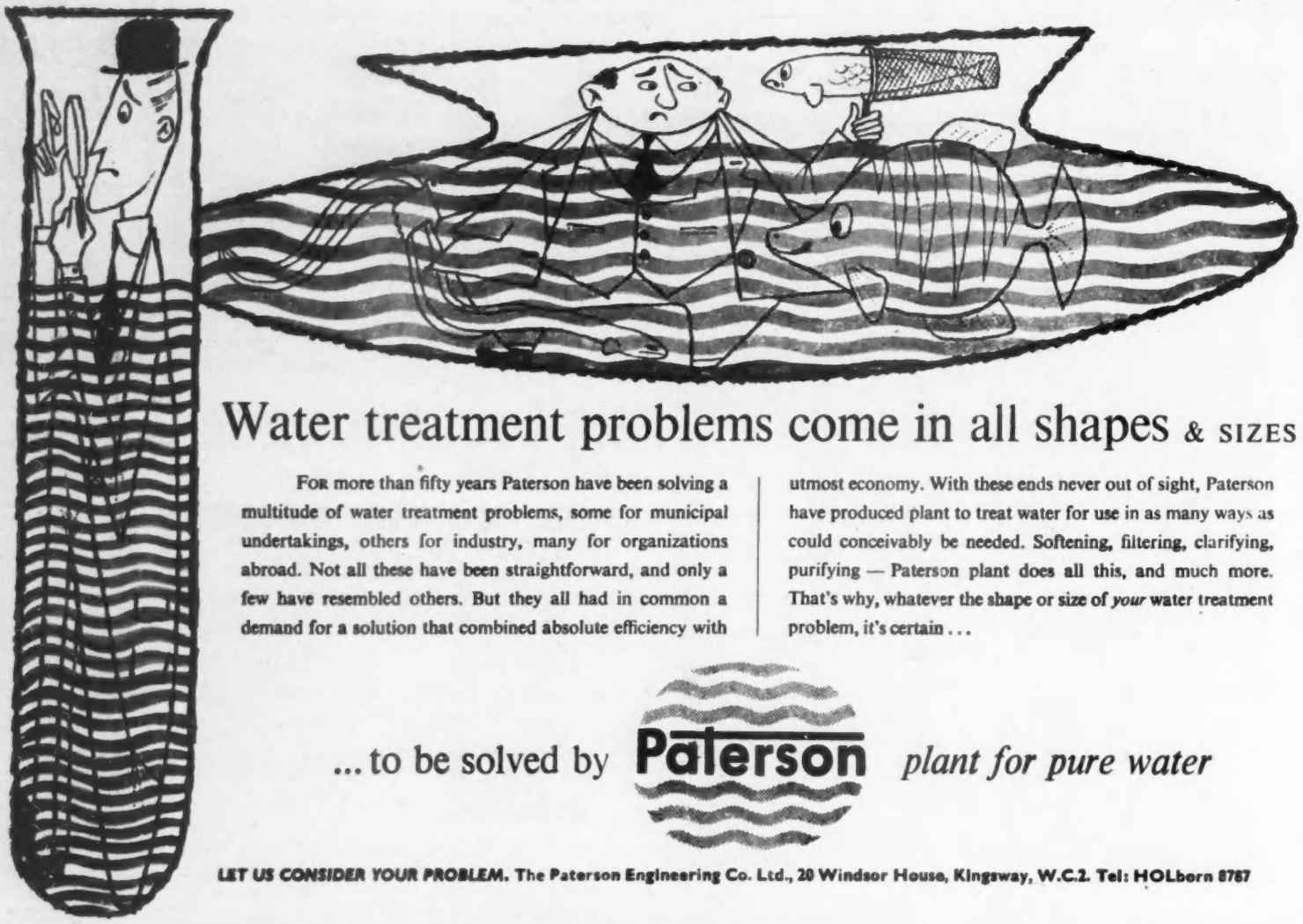

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THE ENGINEER

No. 5330 MARCH 21, 1958 VOL. 205

NUCLEAR POWER PROGRESS AND PROBLEMS

Great Britain's rapid progress in the peaceful development of nuclear power was discussed last Tuesday by Sir John Cockcroft in the James Forrest lecture, abstracts from which are reproduced on page 435 of this issue. Sir John began by describing some of the advances that have been made in the last three years since the publication of the Government White Paper outlining a programme for the building of nuclear power stations to generate 1500MW to 2000MW of electricity by 1965. This programme was based upon the conservative assumption that improvements in design might enable the output sent out from the first group of C.E.A. stations to be raised to 100MW or 200MW, compared with the 70MW of Calder Hall. In fact, however, engineering developments have been much more rapid than was envisaged in the more conservative estimates. First, there has been a considerable increase in the size of the gas-cooled, graphite-moderated reactor and, correspondingly, in the quantity of uranium fuel in each reactor. Secondly, by raising the temperature of the fuel element surface from 410 deg. to about 425 deg. Cent., by effecting a 50 per cent increase in the carbon dioxide cooling, and by making improvements in the heat transfer surface, the amount of heat that can be extracted from each ton of uranium has been more than doubled. By incorporating advances such as these in the nuclear power stations at Berkeley, Bradwell, Hunterston and Hinkley, design outputs of 275MW to 500MW have been contracted for, instead of the 100MW or 200MW forecast in the White Paper.

But that is not all, for in this new amalgam of technologies involved in the design of nuclear power stations, progress is continuous. The figures we have just quoted represent the effect of "freezing" the design at a given moment. Eighteen months later, to-day's designs would show even greater outputs per reactor. For example, as was pointed out recently by Mr. A. L. G. Lindley, of The General Electric Company, Ltd., it is now possible to build a single reactor capable of a net electrical output of more than 400MW, which means that a two-reactor station would have an output of 800MW sent out. What effects are these developments likely to have on the British nuclear power programme? Obviously, fewer nuclear power stations would be needed to fulfil the existing programme. Only six 800MW stations (in addition to the four totalling 1400MW already ordered) instead of the eighteen or twenty stations originally envisaged in the White Paper, would suffice to produce the required output of 6000MW by 1965. Clearly, the capital costs per megawatt of output would be greatly reduced, as would the cost per unit sent out. These improvements, then, tend to advance the time when the unit costs of nuclear power will be no more than those of conventional power. Assuming that the four stations now being built will generate electrical power at costs comparable with those of fossil-fuel stations, the next group of nuclear power stations should have appreciably lower generation costs. Other possible advantages of the requirement for fewer stations of larger output are that the difficulties of finding suitable sites may be eased and that the task of completing the programme by 1965 is likely to be achieved with less effort.

The present phase of development in this country is clearly aimed at reducing the cost of nuclear power stations, to produce electricity more cheaply than by conventional means. At present progress towards this goal is so rapid as to present special problems to those with a heavy stake in the industry, and to the large industrial consortia, in particular. These groups must, for example, devote considerable resources in capital and manpower towards research and development in rapidly-changing technologies. If these efforts are too timid they may be inadequate; however discriminating they may be, not all are likely to be remunerative. To secure any return on these investments, more capital and manpower must be deployed in setting up a design and contracts organisation. Yet, if fewer nuclear power stations are required, there is a risk that these design and contracts teams will be under-loaded. Nor is it very likely that the export potential will counteract this tendency. For countries like Germany and Japan, in particular, may well prefer to build nuclear power stations, under licence, to British designs, importing perhaps no more than the fuel elements and charging machines and some of the more specialised instrumentation. Such a situation was envisaged some time ago when Sir Claude Gibb said at a press conference that British consortia might have to be content with selling "know-how" rather than complete reactors or power stations. The difficulty facing these groups of firms is very real. They will need all their resilience and ingenuity to adjust their commitments so that they can devote a substantial effort to research and development in fields where the frontiers of knowledge are rapidly widening, while the rewards are uncertain; at the same time they must strive to maintain a highly skilled production organisation which is sufficiently flexible to meet varying demands and sudden overloads. For no one can foretell with any degree of certainty how the situation will develop.

EDUCATING THE MODERN CHILD

For some time the Central Advisory Council for Education has been studying the educational needs of boys and girls between fifteen and eighteen years of age. There has just been submitted to that body by the Association of Teachers in Technical Institutions a memorandum on the subject which is both stimulating and exhilarating. For the teachers concerned have fully grasped the fact that we live in an age of revolutionary change. They state unequivocally, "Our national economy depends upon applied science and technology. There is an ever-growing demand for scientists, technologists, technicians and craftsmen. New industries and new crafts are

springing up, old industries are being mechanised and old crafts modified by the impact of a scientific revolution which influences and will influence, more and more, every facet of our lives national and local, public and private." The Association goes straight on to " question whether the traditional pattern of curricula in our schools is equal to these developments " ; and it is convinced that " nothing short of a major shift of emphasis from ' Arts ' to ' Sciences ' will meet the crisis."

Very possibly the part of the memorandum which will attract particular attention is that in which the teaching of dead languages in grammar schools is attacked. For it will prove anathema to some that the Association should " wish to see the removal of Latin and Greek from the timetables of all but a minority of pupils and the time thus saved devoted to a broad treatment of science and its applications." This, it will be suggested, is an attack on the cultural side of education. Yet in our modern civilisation, based upon the application of science and in that respect totally different from any that has preceded it, is it really reasonable that ten to fifteen periods a week, out of thirty-five, should be devoted to two or three foreign languages including one and sometimes two classical languages, as against a mere five periods per week for what the Association terms " snippet " treatment of general science ? But there is far more in the memorandum than an attack on Latin and Greek. First and foremost the Association points out that the industrial and economic problems of this country cannot be solved merely by educating rather more people than before to the highest standards. The objective will have to be that of developing to their full potential the minds of all children who pass through the schools. For besides scientists and technologists we need much greater numbers of technicians and well-educated craftsmen. For this reason the Association recommends a considerable expansion in the provision of secondary technical schools providing a " liberal education with science and its applications as the core and inspiration." This sounds suspiciously like a plea for some degree of specialisation in school curricula, a development to which the majority of those concerned with higher education are opposed. Yet it may be true that "vocational motivation, judiciously introduced, has a powerful incentive value " ; and the Association asks with some pertinence " How can a boy be attracted to engineering, for example, except by being encouraged to explore some of the typical activities associated with engineering? " Amongst equally stimulating and equally debatable points are a recommendation that there should be a greater degree of uniformity in the requirements of groups of professional bodies about the criteria of a good education up to the age of sixteen ; and that there should be greater flexibility amongst universities in faculty requirements and some moderation of standards of admission in the interest of giving sixth form pupils the opportunity of enjoying a broad education.

The Association has also some things to say about school leaving which we believe to be wise. There is a natural tendency to assume that all children would benefit by voluntarily remaining at school for at least one year beyond the present school-leaving age ; and, in fact, the number of children who do stay on at school is rising quite rapidly. The Association suspects, however, that " many boys and girls are specialising in grammar school sixth forms on work which will not best prepare them for their own future success in employment or for the country's needs." It suggests, as an alternative, that they would do better in secondary technical schools, in full time or sandwich courses in technical colleges, or even as apprentices with part-time education. Interestingly, the Association is lukewarm to the raising of the minimum school-leaving age. It holds, amongst other factors, that " the expansion of part-time day release education is a more fertile field of development." Indeed it advocates part-time day education for juveniles not receiving full-time education as a compulsory measure, pointing out that, though the growth of this form of education has been " spectacular " in industrial and professional employment, there has been " conspicuous neglect " in commerce and certain other types of employment and that there are " whole industries in which technical education for adolescents is an urgent need and where it is at present confined to a small minority " ; and it holds that for certain kinds of courses, release should be extended to one and a half or two days. We print extracts from the memorandum on page 431.

NOT A PLEASING AFFAIR

It was disclosed in London recently that a long standing dissension over the world speed records claimed to have been established with a British motor-cycle on the Bonneville Salt Flats, Utah, in September, 1956, may be referred to a court of law. The situation is that on September 6, 1956, a Triumph motor-cycle ridden by Mr. John Allen attained on Bonneville Salt Flats in Utah measured speeds of 214 m.p.h. over a kilometre and 214·5 m.p.h. over one mile, thus exceeding the previous record, set up only a few days earlier by a motor-cycle of N.S.U. Werke manufacture, of 211 m.p.h. It seems not to have been disputed until many months later that every item of procedure laid down by the Federation Internationale Motocycliste was meticulously complied with. A " notice of record " was issued by the Federation Internationale Motocycliste to Mr. John Allen, a United States citizen, on September 17, 1956. Now according to the *Code Sportif International*, " during the three calendar months after the notice of record has been published an objection to the record may be lodged and will be investigated. At the end of the three months, if no objection has been lodged or if an objection has been lodged and found not to be valid, the record is confirmed and inscribed in the Register of World's Records." On October 29, 1956, the N.S.U. Werke A.G. wrote to Mr. Nortier, an official of the F.I.M. But under a Counsel's opinion in this country its letter did not amount to a protest or objection. It was " at the highest only a request that F.I.M. would check the record." Under the circumstances, which must have been very disappointing to the N.S.U. Werke, this must, in our view, seem a very reasonable request. Thus, no objection having been received, the record should have been regarded as confirmed on December 17. But, in fact, in April, 1957, the record was formally rejected by the F.I.M. on the grounds that a certain certificate concerning the timing apparatus had not at that time been received from the California Institute of Technology. The Institute sent the certificate in May, 1957. In the opinion of a Queen's Counsel, this "purported rejection was . . . . . of no effect as the World's Record has become automatically confirmed three months after September 17, 1956, i.e. on December 17, 1956." The F.I.M. finally rejected the record in October, 1957, prompting our contemporary *Motor Cycling* to comment " The ideals of motor-cycle sport died in Paris last Saturday."

It is natural to inquire how the Federation Internationale Motocycliste can have come to take up what is apparently an indefensible position. But no information has been

so far made available by the Federation. If the conduct of this matter by the F.I.M. has been, as is alleged, unconstitutional, one requires to know how it has passed without objection from within that body. For the Auto-cycle Union, governing body of the sport in this country, is represented upon these international organisations, and one would expect the Union to exact justice for all comers wherever domiciled. But the Secretary of the A.C.U. believes that the constitution of the F.I.M. forbids the A.C.U. to appeal to the courts upon any such issue even should it feel inclined to do so (a point upon which we have no knowledge) while it continues to be affiliated to the Federation. Thus, if the case is to be fought legally, the Triumph Engineering Company, Ltd., must itself do the fighting. Unfortunately there will then be no guarantee that the case of Mr. Robert Burns' claimed sidecar record of 176½ m.p.h., recorded with the same timing apparatus and still unconfirmed, will be reviewed.

RATING OF ENGINEERING SOCIETIES

The first thing to note about the decision of the Lands Tribunal that the Institution of Mechanical Engineers shall be exempted from paying rates, is that an appeal by Westminster City Council is possible. Until, therefore, that Council decides whether or not to appeal—it has some weeks in which to make up its mind—the matter can still be regarded as *sub judice*. The second point to note is that, even should there be no appeal, the case is a test one only in the very limited sense of showing that an engineering institution may, under certain circumstances, be relieved of rates. It does not mean, supposing the Council accepts the decision, that, almost automatically, a number of other institutions and societies can also expect to be relieved of rates. For the question as to whether a society can claim exemption turns upon the nature of the activities for which the society uses its building and in a large degree also on the general purposes and activities of the society. When this particular issue about the Institution of Mechanical Engineers is finally decided, therefore, it will be necessary for other societies contemplating the possibility of seeking relief from rates to study the judgment and the evidence submitted in detail and with great care. For whatever the outcome as it affects the Institution of Mechanical Engineers some of the activities of some of those societies may be seen clearly to conflict with the conditions necessary for a successful application ; and some of their activities, differing from those of the Institution of Mechanical Engineers, may not be covered by the judgment at all. Furthermore, those societies will need to decide whether compliance with conditions which might relieve them of rates might also unduly restrict activities which they have pursued in the past or might wish to pursue in the future. In fact whether or not any given society will be able to gain exemption from rates or will even want to comply with the conditions will depend upon an individual consideration of its case. What the present case, when finally decided, will do will be to give guidance to other societies as to the relative importance of various factors influencing decisions of the Central London Local Valuation Court and of the Lands Tribunal to which the Institution of Mechanical Engineers appealed after the Court had assessed it liable to rates. It will, that is, help them to make up their minds whether or not it would be worth while to claim exemption, taking into account the legal expenses which may be involved.

"VANGUARD" SATELLITE LAUNCHED

Another American satellite is now circling the earth. It is particularly satisfactory to be able to report that it was set in its orbit by a U.S. Navy "Vanguard" rocket, which was fired last Monday, March 17. For the U.S Navy has been dogged by misfortune in its efforts to emulate the Army in putting a satellite in orbit. Moreover, unlike the Army rockets, the "Vanguard"—a three-stage affair—has been particularly designed for research purposes. The actual satellite is tiny. It is a 6in sphere weighing only 3 lb. By comparison, the Army's "Explorer" weighs nearly 31 lb. But the "Vanguard" satellite separated from the third stage of the rocket, whereas the instrumentation of the "Explorer" is contained in the burnt-out third-stage shell. The third stage of the "Vanguard" weighed about 50 lb and is itself circling the earth.

The new satellite has a greater mean distance from the earth than any of those previously set up by the Russians or the Americans ; and in consequence it takes a longer time—135 minutes—to circle the earth, as compared with 115 minutes for the "Explorer" and less than 100 minutes for the "Sputniks." Perigee is about 400 miles above the earth's surface, apogee about 2500 miles. The satellite contains two radio transmitters, one of which is operated by solar batteries and is consequently expected to remain at work almost indefinitely. The satellite is so far above the earth's surface at perigee that it can reasonably be expected to remain in orbit for very many months and possibly several years. This success will no doubt encourage the U.S. Navy to proceed in due course with the launching of a full-size "Vanguard" satellite carrying a fuller complement of instruments and weighing some 20 lb.

The Engineer — 100 Years Ago (MARCH 19, 1858)

"THE ATLANTIC TELEGRAPH"

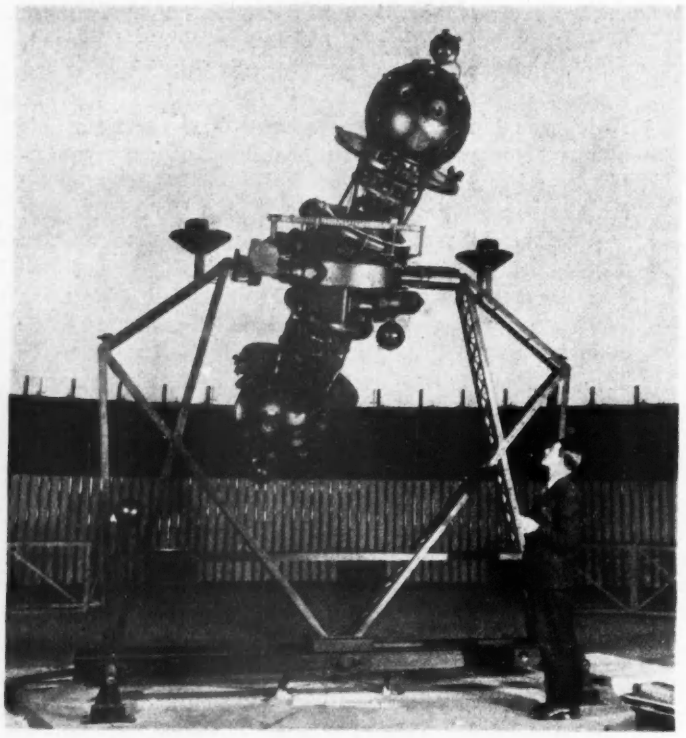
"It is satisfactory to find that the late failure of the Atlantic Telegraph Company to lay their cable in the ocean has in no way damped their ardour in the attempt to accomplish the great object in view. To connect the old and new worlds by a telegraphic communication is indeed an exploit which may well incite them to continued exertion until their object be finally attained, and much honour will it deservedly bring to all engaged in the work should it be successfully completed . . .

"With regard to the experiments which have lately been made upon the Atlantic cable, the results show that five or six words can be conveyed along its total length every minute. Taking the rate at five words per minute, this will equal about 7,000 words in the twenty-four hours, during the whole of which the wires will doubtless be doing duty. That this rate of talking will anything like satisfy our transatlantic friends no one for a moment expects ; and there is little doubt that, should success attend the laying of the cable when again attempted efforts will be made, both in this country and America, to lay at least a duplicate line, if not several of them, forthwith. The Niagara and the Agamemnon are the two vessels which it is again intended to employ in laying the cable. Considerable alterations have been made in the paying-out machinery since it was last used, and there is every hope that accidents of the kind before met with will this time be avoided. We trust, for one thing, that it will not be forgotten, at any cost, to thoroughly man the vessels, not only with the full complement of men as ordinary steamers of their respective classes, but as vessels engaged in a work in which the want of a hand may mar the whole undertaking. In any work necessitating close attention and a continued watchfulness, no men should be allowed to remain long at their posts, and we are disposed to think that even four sets of those engaged about the cable and paying-out machinery would be none too many to ensure that absolute control over the working of the system which must be kept steadily going, without any cessation, for a fortnight, or possibly more . . . ."

London Planetarium

No. I

On March 19, the official opening took place in London of the first planetarium in Great Britain and the Commonwealth. In our issues of May 17 and 24, 1957, we reproduced a lecture given by Professor Dr. Walter Bauersfeld, of the firm of Carl Zeiss, German Federal Republic,. before the Institution of Mechanical Engineers, in which the speaker described his invention of the projection planetarium nearly forty years ago, as well as the incidental invention of shell concrete. Since its first appearance the planetarium has developed into a universal instrument capable of reproducing, greatly speeded up, and with an accuracy and in a realistic manner which are truly extraordinary, those astronomical events, present, past or future, which can be observed with the naked eye. This article describes the projection planetarium, including its most modern developments, and in particular the installation which has now become available to the public.



WITH the opening on March 19 of the London Planetarium, at Madame Tussaud's, there will become available in this country a piece of equipment of unique educational utility. For by means of the projection planetarium one is able to view, in realistic representation, what can seldom or never be seen in similar completeness in nature. The astronomer can observe the starry sky for minutes or hours only at a time. He cannot see the stars in the neighbourhood of where the sun happens to be, and in our latitudes large parts of the southern sky never come into view at all. Moreover, all secular changes must in the nature of things remain invisible to the naked eye, and are only detectable by careful observation through instruments.

By contrast with this state of affairs, in the planetarium we are subject to no such limitations. On the spherical dome over the auditorium, projected from the instrument at the centre, appear the images of all stars down to magnitude 5^m8, i.e. all stars visible to the naked eye, numbering about 8900, as well as the sun and moon and five planets Mercury, Venus, Mars, Jupiter and Saturn. We obtain, as it were, an inside view of the heavenly clockwork as seen from one of the wheels of the mechanism, the earth, and in so doing, are subject to no limitations of either space or time. Simple controls allow the instrument to be adjusted for any degree of latitude, and we can observe the changes as we travel from the north to the south Pole Unlike the real sun, the projected image of the sun does not by its glare obscure the daytime stars, so that observations can be carried on continuously throughout the twenty-four hours.

It may be thought that the vastness of the starry night sky could never be adequately represented by light spots shining on a white ceiling, but anybody who has witnessed the instrument in operation will most certainly be convinced of the opposite. In general, differences in brightness can adequately be represented by differences in diameter of the image ; the angle subtended at the observer's eye remains sufficiently small to maintain the illusion of a point source. This is true for all but the brightest objects, for which special individual projectors have been provided. As regards the impression of vastness of space, it must be remembered that the performance takes place in semi-darkness, and that the differences in distance of all light spots which are within the field of acute vision at any instant are small. The dome is sufficiently large for parallax between the two eyes to be inadequate for judging distances, so that the observer has no proper means of estimating the true distance and readily succumbs to the illusion, even imagining the background to be of a dark blue colour, which is not actually the case. One consequence of this extremely natural appearance of the sky is that it is taken for a fixed datum of reference, so that one easily obtains the very unpleasant impression that it is not the sky, but the floor, which is tilting.

What is, however, perhaps the most striking aspect of the design is its ability to compress vast periods of time into hours, minutes or even seconds, and thus present to the viewer a clear impression of changes which normally remain imperceptible. Not only the past, but also the future, becomes accessible to demonstration, the accuracy of the machine being such that a term of 129,000 years (five precessional periods) can be covered in either direction without any but very slight errors in the relative positions of the heavenly bodies.

During such long spaces of time, the movement of our solar system as a whole begins to become apparent. This effect can be demonstrated qualitatively by moving the whole planetarium instrument in the direction in which the solar system moves in nature. This has the effect of spreading out the stars on the side of the dome towards which the instrument moves, so that they look as if approaching, and causing the stars at the opposite side to converge, so that they seem to recede. Apart from this general effect, certain individual stars exhibit a considerable proper motion. In the most recent instruments those planetarium stars for which this motion has been measured with a sufficient degree of accuracy, are represented by special projectors which, by means of geared prisms, are able to project the actual paths.

In addition to the main projector, there are smaller projectors for comets and shooting stars. Most instructive is the solar system projector which produces a broadside-on view of the planets circling round the sun, as they would appear from a distance of 1·7 times the radius of the orbit of Saturn. Also at the disposal of the lecturer as part of the main machine are projectors showing the signs of the zodiac and the names of the principal constellations, as well as various celestial lines of reference. A projected arrow allows the lecturer to point out individual objects on the planetarium dome.

The planetarium instrument has been described as " an assembly of a few gear-driven projector lamps in a suitably adjustable frame." Although this description gives an idea of the ingenious simplicity of the basic conception, when applied to the elaborate finesse of the actual arrangement of this masterpiece among scientific toys, with its 29,000 component parts, it would seem to be very much an understatement.

As there is, however, " no (entirely) new thing under the sun," it may be of interest to look at previous achievements in this field.

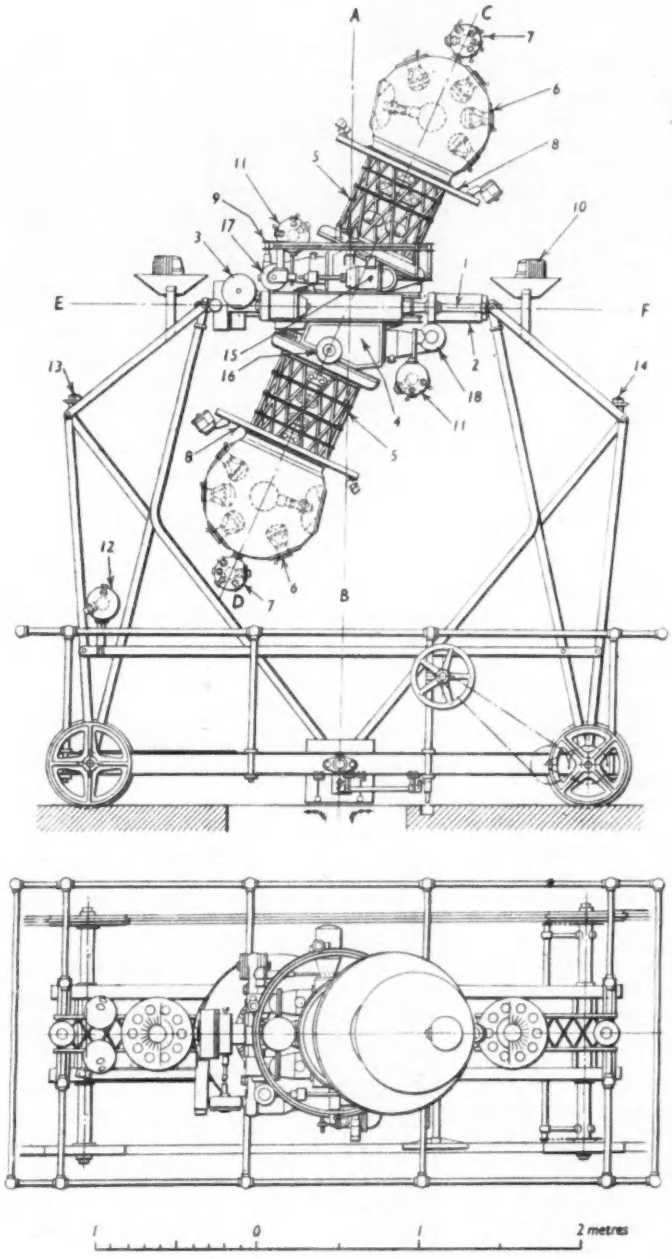
History

Attempts to represent the firmament by models go back to antiquity. Following the teachings of Anaximander (sixth century B.C.), the universe was represented as a sphere (with the earth imagined at its centre) carried on his shoulders by the giant Atlas. Celestial globes made to illustrate the famous astronomical poem " Phenomena " written by Aratus in the first half of the third century B.C. were called Aratus globes after the poet, and were in use Byzantium until the late Middle Ages. The first real " planetarium," i.e. a globe incorporating a mechanism for the motion of the sun and planets, is ascribed to Archimedes. After the fall of Syracuse, in which Archimedes was killed, the instrument was taken to Rome, where it was regarded as a marvel. Several other planetaria were built on this pattern, the remains of one being recovered recently from an ancient wreck near Antikythera.

It is a disadvantage of the celestial globe that the appearance of the constellations

is the mirror image of what is actually seen from the earth. In modern times therefore there came into existence a number of hollow globes which the observer could enter. A design of this kind which has been preserved is the Gottorp globe, built between 1644 and 1664 for Duke Frederic III of Holstein by Andreas Busch to the design of Adam Olearius, and presented to Peter the Great in 1713. This is a 3·2-ton hollow copper sphere, 4m in diameter, mounted at 54½ deg. to the horizontal and rotated once in twenty-four hours by water power, or turned from inside. The same idea is followed in the 15ft diameter Atwood globe at the Academy of Sciences of Chicago (built 1912-13). While the Gottorp globe had the stars painted on the inside, the Atwood globe presented them by perforations in the metal which were illuminated by external light. With such globes it was always difficult to arrange in the confined interior a mechanism for the solar system. In the Atwood globe the movement of the sun along the ecliptic is shown by an electric lamp, and that of the four innermost planets by providing a series of holes near the ecliptic and lighting successive perforations in turn, but it is clear that it would be impossible to show by this means the effect of precession. Of particular interest in the present context are therefore instruments like that of Archimedes of which unfortunately no details have been preserved. A great stumbling block to the development of such instruments was the Ptolemaic theory, and it was only after Copernicus that real advances were made, notably by the planetarium constructed in 1682 by Christian Huygens. It was Huygens who invented the method of continued fractions for calculating the gear ratios, such as was subsequently used for the Zeiss planetarium. At the beginning of the eighteenth century, George Graham constructed a planetarium for Prince Eugene of Savoy, and an improved version of this, built by John Rowley for Charles Boyle, fourth Earl of Orrery, has led to such instruments being called "orreries" in the English-speaking world.

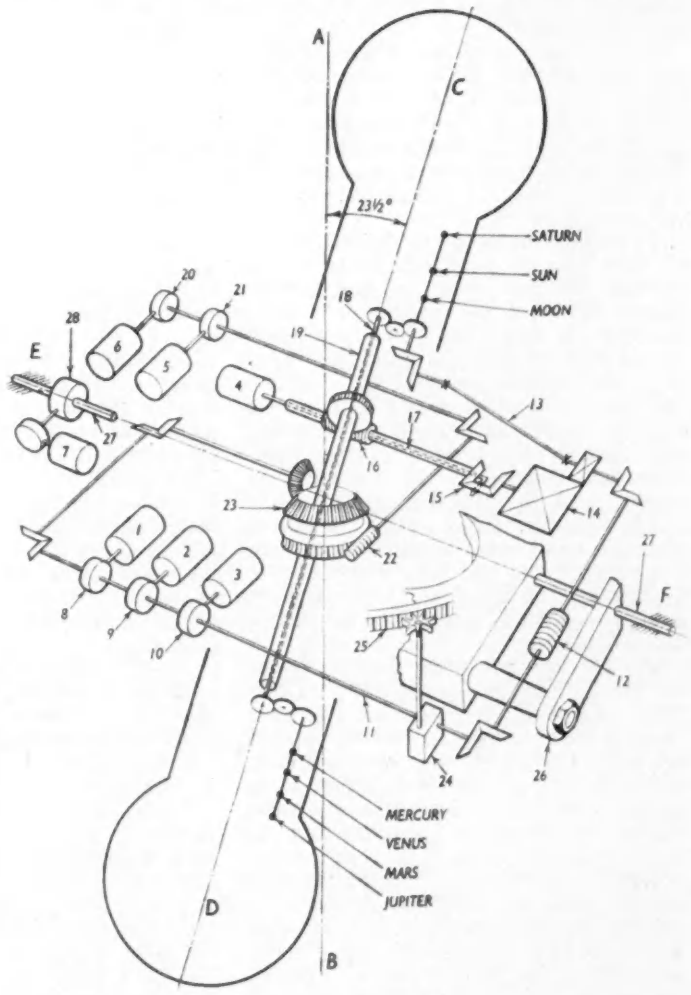
Among famous mechanical planetaria is that built by Eisinga for the Dutch university of Franeker (1773-80) and the Copernican planetarium at the German Museum in Munich, built by the Zeiss chief engineer, Franz Meyer (1923). In the latter apparatus,



A, *B*—Polar axis.
C, *D*—Axis of ecliptic.
E, *F*—East-West axis.

1—Stub shaft.
2—Yoke.
3—Latitude drive.
4—Main block.
5—Planetary cage.
6—Star carrier.
7—Constellation and precession dial projectors.
8—"Ruffs" housing special projectors.
9—Lattice ring.
10—Dome lighting (white and blue).
11—Globes with six projectors for the equatorial grid reference system and the ecliptic.
12—Two lobes with two projectors each for the meridian.
13—Horizon illumination for morning twilight.
14—Horizon illumination for evening twilight.
15—Year counter.
16—Precession counter.
17—Three motors for annual movement.
18—Two motors for diurnal movement.

Fig. 1—Zeiss planetarium instrument



A, *B*—Polar axis.
C, *D*—Axis of ecliptic.
E, *F*—East-West axis.

1 to 7—Motors; 1, 2 and 3, annual; 4, fast precession; 5 and 6, diurnal; 7, latitude.
8, 9 and 10—Worm and planetary reduction gearboxes.
11—Output shaft.
12—Multi-disc safety clutch.
13—Universal shaft.
14—Spur gearbox.
15—Differential.
16—Precession worm and worm wheel.
17—Output shaft of motor (4), driving arm of intermediate gear of differential.
18—Planetary transmission shaft, revolving at the rate of ten revolutions per planetarium year.
19—Precession shaft.
20 and 21—Worm and planetary reduction gearboxes.
22—Worm and worm wheel ring for diurnal drive.
23—Bevel pinion and gear ring for annual drive.
24—Sprocket drive.
25—Lattice ring, parallel to celestial equator.
26—Instrument yoke, at right angles to *A*, *B*.
27—Stub shafts clamped to supporting frame.
28—Two-stage reduction drive for latitude alterations.

Fig. 2—Drive mechanism for planetarium instrument

which occupies a room 12m in diameter, the sun and planets together with their moons are represented. Lamps are hung from electrically driven carriages running on overhead elliptical tracks corresponding to the orbits of the six inner planets, with the sun fixed at the centre. The earth is represented by a carriage travelling along a track let into the floor. An observer standing on this carriage can, by using a periscope, obtain a geocentric view of the solar system. The relative times of revolution are correctly represented, with a complete year passing in twelve minutes, but the spatial relationships are not to scale. This fact, together with the lack of a realistic background, does not give the observer the illusion of watching the real night sky.

The invention of the Zeiss projection planetarium was made by Professor Walter Bauersfeld in March, 1919. In last year's James Clayton lecture*, Professor Bauersfeld gave an interesting account before the Institution of Mechanical Engineers, of the development of the projector, as well as that of shell concrete which was made in connection with the construction of the planetarium dome.

Between the conception of the original idea and the first public showing of the finished instrument in Munich in October, 1923, lay an interval of over three and a half years. This and the fact that the design calculations cover some 600 pages of foolscap is an indication of the difficult details which had to be mastered.

As regards the scope of the instrument, we have already mentioned some of the principal features. Out of nine known planets five are represented, while a sixth, the earth, is taken into account as being the moving observation point to which all other celestial motions are referred. The planets revolve round the sun in elliptical orbits of varying eccentricity, with the sun in one focus of the ellipse. This fact determines the variations in orbital speed in accordance with Kepler's Third Law (the radius vector sun-planet sweeping equal areas in equal times), and it is those speed variations which have to be taken into account if the planetary motions are to be shown with the desired degree of accuracy.

The two most prominent heavenly bodies are the sun and moon, and although they differ enormously in actual size (the sun's diameter being about 1,390,000km against the moon's 3470km), their distances from the earth are such that both appear to be about the same size. The sun is at a mean distance of 150 million kilometres from the earth, while the moon is at a distance of 385,000km, so that both subtend the same angle of about half a degree at the edge of the observer, the moon appearing slightly smaller. While absolute distances are not a matter with which the planetarium is concerned, the relative sizes of the sun and moon are accurately represented, as are the moon's phases and the details of its orbit.

The earth revolves round the sun once in 365¼ days (one tropical year), giving rise to the apparent motion of the sun along the line of the zodiac, or ecliptic. This movement is opposite to the apparent diurnal rotation of the heavens, and its path is almost stationary in space, since the plane of the earth's orbit is almost stationary. The extension of the terrestial polar axis forms the celestial polar axis about which the diurnal revolution of the heavens takes place, and the projection upon the sky of the terrestial equator forms the celestial equator which is inclined 23½ deg. to the ecliptic. Where the two intersect are the equinoctial points, the Aries point or vernal equinox, and the autumnal equinox. Because of the precession of the earth's axis about the axis of the ecliptic, a motion which it takes 25,800 years (one "platonic" year) to complete, the position of the celestial polar axis and celestial equator undergo a corresponding change of position, so that the equinoctial points advance about fifty seconds of arc each year, making the tropical year about twenty minutes shorter than the siderial year, i.e. the duration of one apparent revolution of the sun in relation to the fixed stars.

By means which will be described, the planetarium exhibits the effects of geographical latitude, diurnal and annual movement and of precession. In the most recent instruments, the various kinds of proper motion of the stars can also be shown. First there is the parallax, i.e. the apparent change in position of a "near" star against an infinitely distant background, due to the annual motion of the earth. If situated at one of the celestial poles, such a star would describe a circle, while a star on the equator would move to and fro, and stars in intermediate positions would describe ellipses. The effect is demonstrated with Sirius, because its parallax of 0·38 second is amongst the largest—it still, however, has to be artificially exaggerated about 10,000-fold in order to render it clearly visible—and because its latitude of 39½ deg. South makes the parallax orbit an ellipse. The choice of Sirius is also motivated by the fact that as the brightest fixed star it is easily picked out.

The second kind of proper motion is the stellar aberration, due to the finite ratio between the speed of light (about 300,000km per second) and the speed of the earth in its orbit round the sun (about 30km per second). The apparent position of the stars appears to be displaced slightly from its true position, in the same direction as the motion of the earth, and by an amount which is constant for all stars and equal to 20·5 seconds. The aberration orbits are similar to the parallax orbits, the two effects being superimposed on each other.

Thirdly there is the secular parallax, an apparent movement of all the stars in a direction opposite to that of the true motion of the solar system within our galaxy (20km per second towards an apex at $\alpha=270$ deg., $\delta=34$ deg.).

Finally there is the effect of the individual motion of each star relative to the galaxy as a whole which can of course only be observed in combination with the secular parallax. This is called the secular proper motion of the star, and for certain stars is of the order of seconds of arc per annum. If the star's distance is known from parallax measurements, as well as its velocity along the line of sight, together with the angular velocity, then the space velocity and path in relation to the sun can be plotted. The space velocity being assumed to be constant, and the path to be a straight line, the secular changes of the star's spherical position can be found by extrapolation. By means to be described this effect can be demonstrated in the planetarium for some seventy-five representative stars for which sufficiently accurate data are known, over a period of 129,000 years (five complete precessional cycles).

Foremost of what is required of the planetarium is extreme accuracy of the representation. Over a time span of four precessional periods the positional error of Mercury, the planet most difficult to represent accurately because of the large eccentricity of its orbit, was not to exceed ±3 deg., while the error in the case of Mars remained within ±2½ deg. Other problems arose in connection with the realistic projection of the moon and its phases, and with that of the Milky Way, to mention only a few. The gear trains for the solar system projectors, while representing the required ratio with an accuracy of the order of one in 10,000,000, had to be designed with the smallest possible number of teeth, in order to keep the transmissions simple and reduce wear.

Concerning the first instrument, it is sufficient to mention here that it embodied already most of the principles of later equipment, other than certain—though important—refinements. It had, however, one great drawback, that it was adjustable only for one latitude (in this case that of Munich) and was not able to project the sky as seen from any other part of the world; in particular large regions of the southern celestial hemisphere were omitted entirely. Altogether, eight instruments of this type were built eventually and installed in various towns of Germany and abroad. Almost at once, however, there arose a demand for a projector adjustable for any degree of latitude. This task was also accomplished, and in May, 1926, the first of the universal projectors went into service at Barmen, to be followed in the same year by those at Leipzig, Jena, Dresden and Berlin. Before the outbreak of the second world war twenty-six planetaria of the second design had been built. During the war two more were delivered (to the U.S.A. and to Sweden), while since 1949 two more have been installed, as well as two early instruments of the first design. The London planetarium, to the constructional details of which we now turn, is the thirty-third projector to leave the Zeiss works and the third to be constructed by the rebuilt Carl Zeiss works at Oberkochen/Württemberg. It is the first to come into service in the Commonwealth.

The Planetarium Instrument

Our illustration, page 420, shows a general view of a Zeiss planetarium of the second (universal) type, such as the London instrument. As has been mentioned, the main difference between this and the earlier design is that the first projector could only represent the sky as seen in one geographical latitude, whereas the second kind, following a suggestion made by Dr. Walter Villiger in 1924, is adjustable for any northern or southern latitude, as may be required by the demonstration.

The instrument is arranged in the general form of a dumbell, the large spherical endpieces containing the fixed star projectors, while the main drives are housed in the centre. In between are a number of cages in which are mounted the individual projectors for the sun and moon and the planets Mercury, Venus, Mars, Jupiter and Saturn. The machine as a whole is supported on a lattice framework which must be very light in order to offer as little obstruction as possible to the beams from the projectors. For the same reason, the instrument itself must be very light and, in order to keep its weight to a minimum, it is made as nearly self-balancing as possible so as to avoid the need for counterweights.

The polar axis of the instrument is *AB*. This axis, which in our illustration is shown in a vertical position, represents the North-South axis of the earth, about which the daily West-East rotation of the earth and the corresponding apparent counter-rotation of

* See The Engineer, May 17, 1957, page 755 and May 24, 1957, page 796.

the heavens take place. By tilting this axis about the East-West axis *EF*, which passes through the centre of the machine and lies in the plane of the planetarium horizon, the geographical latitude can be altered at will. With *A* at the top, the projector is at the North pole, with *A* at the bottom it is at the South pole, with *AB* horizontal it is at the equator, and so on.

At an angle of approximately 23½ deg. from *AB* is the main axis of the machine *CD*, which also passes through the centre. This represents the axis of the ecliptic, its direction being normal to the plane of the earth's orbit round the sun. The angle between the two planes is, of course, the same as that between the equatorial plane and the ecliptic.

The instrument is supported on the lattice frame by the stub shafts 1 shown in Fig. 1, which are fixed to the frame and are able to rotate in bearings in the yoke 2 which is at right angles to *AB*. A geared drive 3 engages with one of these shafts, enabling the whole instrument to be turned about the East-West axis *EF* in seven minutes. Mounted rotatably on the yoke by means of large roller bearing slewing rims and connected with each other through the hollow centre of the yoke, are the two blocks 4 housing the main drives. On the latest models, the balls of these slewing rims run in races formed by four rings of steel wire. When such a bearing is first assembled, the harder steel balls are rolled under pressure into the wire rings, forming tracks which ensure a perfect fit without any slackness. Similar rims support the end pieces containing the planetary cages 5 and fixed star carriers 6.

Smaller spheres 7 at the ends of the star carriers house the constellation projectors, while individual projectors for bright stars, variable stars and those whose proper motion is to be demonstrated, are situated on the two "ruffs" 8.

The Main Drive.—Besides the drive for the latitude adjustment, provision is made in the machine for representing the diurnal and annual rotations of the heavens, as well as the slow precessional movement, in the exact relationship in which these occur in nature, but greatly speeded up. In addition it is possible to show the precessional effect by itself at a still further accelerated rate. In order to maintain at all times the correct setting of the instrument which has been accurately adjusted for January 1, 1900, all gears remain always in engagement, and there are no clutches or couplings which can be disconnected. No provision has been made for stepless speed changes, as it seemed desirable to preserve the correct time relationships throughout any particular demonstration.

Referring to Fig. 2, it may be seen that altogether seven motors are provided, including the one for the latitude drive. They are ¼ h.p., 220V, single phase a.c. motors running at a nominally constant speed of 1380 r.p.m. Various speeds of the machine can be obtained by running either the "annual" or the "diurnal" motors, singly or in combination, and either forwards or in reverse.

As the illustration shows, the annual motors 1, 2 and 3, drive a common shaft 11 through the worm-and-planetary differential reduction gearboxes 8, 9 and 10. These motors can run off one year in twelve minutes, four minutes and eleven seconds, respectively, and various combinations give annual movements of three and six minutes and ten seconds. This "annual" movement shows the heavens as they would appear if the earth did not rotate about its own axis, but merely revolved round the sun. This greatly facilitates the observation of the sun's movement relative to the ecliptic and the revolutions of the planets.

The same movement, but with the rotation of the earth's axis superimposed, is obtained by using the diurnal motors 5 and 6, singly or in combination. These motors drive the polar axis through reduction gearboxes 20 and 21, a set of right-angle bevel gears and the worm and wormwheel 22. The diurnal movement takes place at a much slower rate than the annual movement. Rotations lasting twelve and four minutes can be obtained by running the motors singly, while rotations of three or six minutes result when both motors are run together, depending on whether they run in parallel or in opposition.

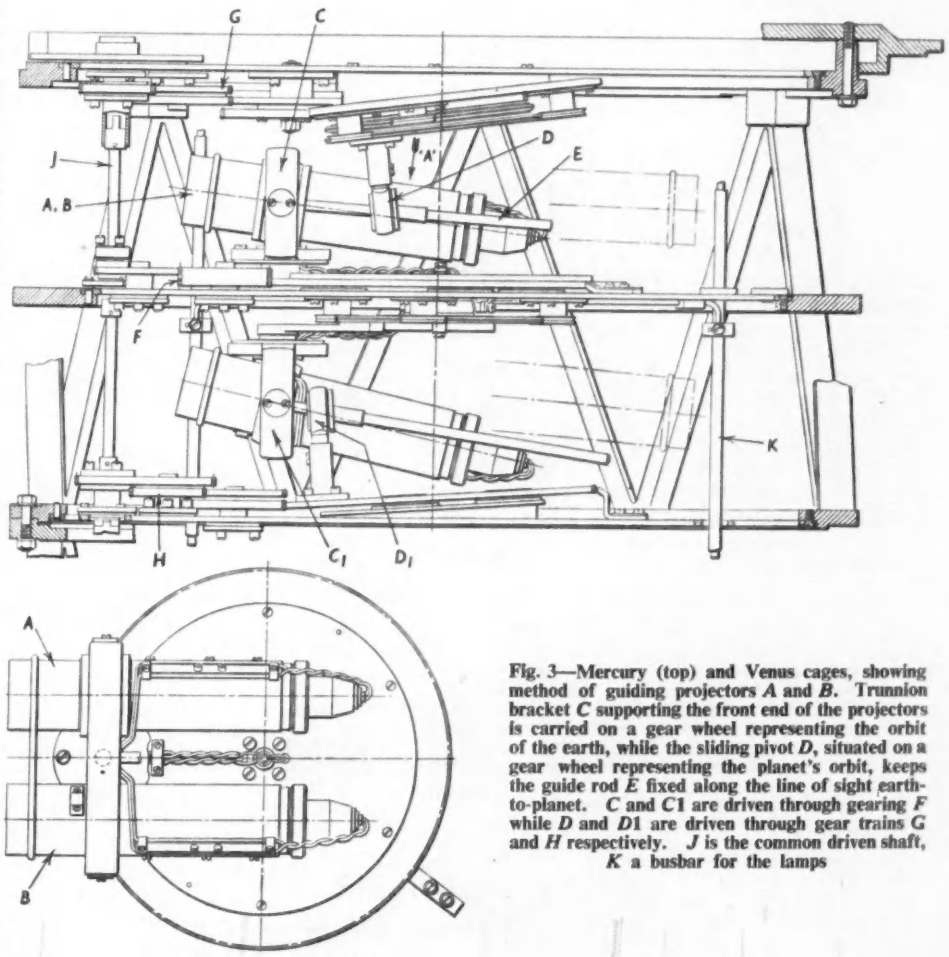


Fig. 3—Mercury (top) and Venus cages, showing method of guiding projectors *A* and *B*. Trunnion bracket *C* supporting the front end of the projectors is carried on a gear wheel representing the orbit of the earth, while the sliding pivot *D*, situated on a gear wheel representing the planet's orbit, keeps the guide rod *E* fixed along the line of sight earth-to-planet. *C* and *C*1 are driven through gearing *F* while *D* and *D*1 are driven through gear trains *G* and *H* respectively. *J* is the common driven shaft, *K* a busbar for the lamps

axis which, from the earth, appears as the precession of the equinoxes, the points in which the celestial equator intersects with the ecliptic. This motion is in a direction opposite to the earth's rotation round the sun, and requires 25,800 years for its completion. In the planetarium this effect is shown by rotating the instrument about the axis of the ecliptic *CD*. In order to do this, the annual shaft 11 drives a 3000 : 1 reduction gearbox 14 through two sets of right-angle bevels and the overload multi-disc clutch 12. The output shaft of the gearbox 14 drives the worm and wormwheel 16 through a differential 15. The wormwheel is mounted on a hollow shaft 19 which passes through the bore of the gear cluster 22, 23, to drive the southern part of the instrument.

While a permanently connected precession movement is essential for the degree of accuracy of presentation which it is desired to achieve, this movement is too slow for demonstration purposes. A fast precession drive, which completes one revolution in four minutes, has therefore been provided by means of a separate motor 4. This drives the arm of the intermediate gear of the differential 15, which is mounted on shaft 17. As the gearbox 14 is non-reversible, it is locked against the drive from the motor 4, which is thus transmitted back to the worm 16.

It may be noted here that the instrument is designed to have a positional error of not more than 1 deg. over a time span of ±4 precessional revolutions, i.e. over more than 200,000 years. Since gear errors anywhere between the diurnal bevel 23 and the precession shaft 19 will be cumulative, some unusually large gear ratios had to be accurately represented. The largest ratio in the machine is that between the diurnal motor 5 and the precession shaft 19, and equals 53,192,797,080 : 1. It would take seventy-four years' continuous operation by means of the diurnal drive to complete one revolution of the axis *CD*.

At the input to gearbox 14 the take-off for the planetary movements is arranged in the form of the universal shaft 13. This provides the drive for the moon, sun and Saturn projector mechanisms in the northern half of the instrument, as shown diagrammatically in Fig. 2. Through intermediate gears and the shaft 18, movement is transmitted to the southern half where the mechanisms for Mercury, Venus, Mars and Jupiter are situated.

Planetary Projectors.—We now turn to that part of the instrument by means of which the sun and moon, and of the planets Mercury to Saturn are shown on the planetarium

dome. It is clear that the astronomical facts which have to be taken into account are of considerable complexity. Certain simplifications can, however, be made, as will appear presently. Each of the celestial objects mentioned is projected by a set of two projectors, the details of which depend on the kind of image required. Two projectors are used in order that occultation of the image by the struts of the machine should be reduced as much as possible.

planets the elliptical orbits can be represented by circles displaced from the centre (the sun) by twice the eccentricity. In the case of Mars, and particularly in that of Mercury, which have orbits with pronounced eccentricities, a closer approximation must, however, be made.

Considerable difficulty is caused by the fact that the times of revolution of the bodies of the solar system are not related by simple ratios. Using Huygens' method of continued

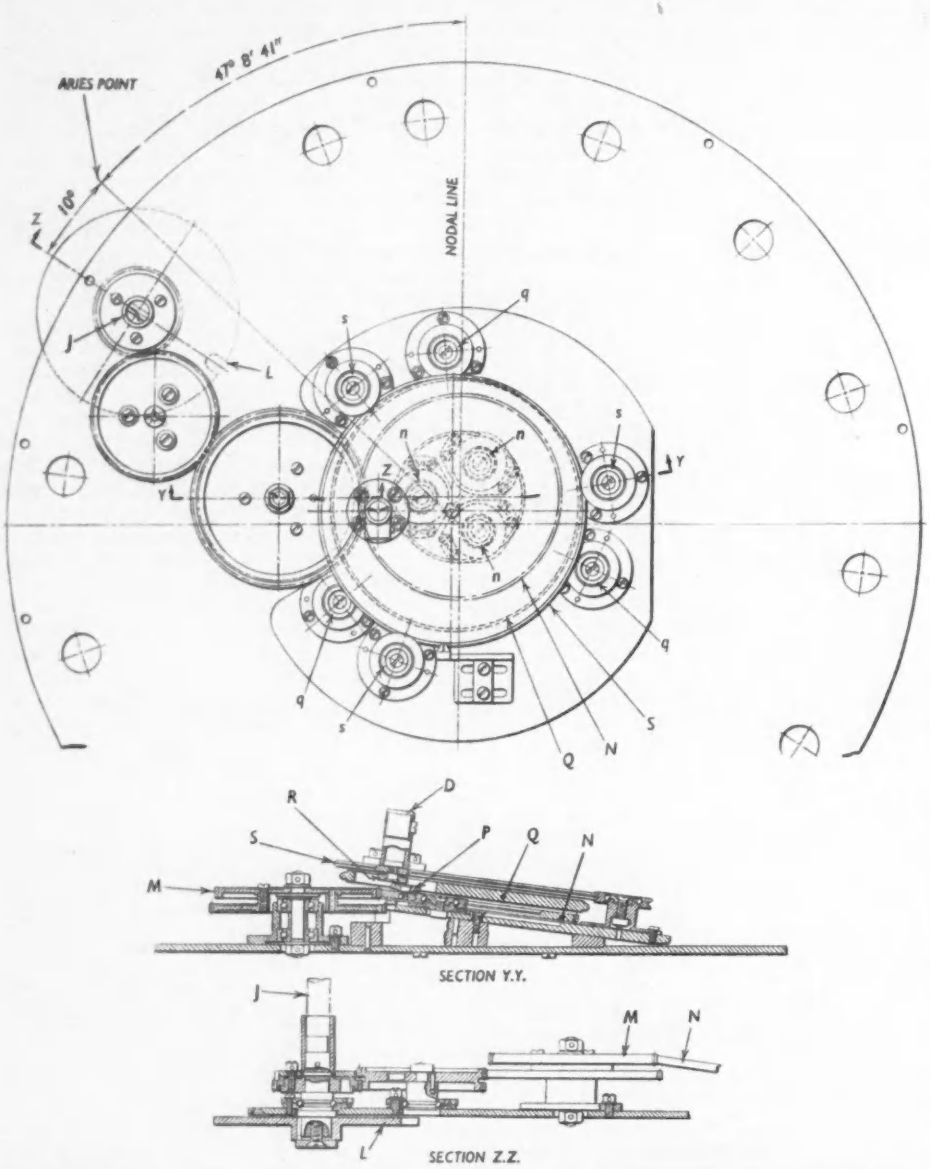


Fig. 4—Detail of Mercury gear train. The drive is taken from shaft *J* and coupling *L*. Gear *M* drives gear *N* which engages by means of a slider *P* with a radial slot in the guide wheel *Q*. A second slider *R*, engaging with the same slot, drives the wheel *S* which carries the pivot *D* for the projector guide rod (not shown). The diagram shows how *N*, *Q* and *S* are supported by rollers *n*, *q* and *s* respectively. The inclination of the assembly (*N*, *Q*, *S*) corresponds to the inclination of the orbit of Mercury to the ecliptic, while the distance between the centres (*N*, *Q*) and (*Q*, *S*) represents the eccentricity of the orbit

The principle upon which the planetary mechanisms are based is as follows. A correct representation on the planetarium sky is obtained if the position of the actual line of sight between earth and celestial body, as well as the angular velocity and acceleration of this line, are accurately represented by the line of sight, &c., of the projector concerned, in either case with reference to the axis of the ecliptic.

What is required, therefore, is a sufficiently precise mechanical reproduction of the orbital motion of the two bodies, together with a pivoted sliding link for keeping the projector pointed in a direction parallel with the line joining the two. For most fractions it required lengthy calculations to arrive at sufficiently accurate and yet acceptably simple gear trains. Not only must the number of gear wheels not be excessive, but the number of teeth must be reasonably small in order to ensure a sufficiently long working life. We shall first discuss the planetary mechanisms in the southern half of the instrument.

Mercury, Venus, Mars, and Jupiter—Each planetary mechanism is housed in a separate cage, comprising two circular end plates between a lattice of spacers (Fig. 3). A shaft driven through gears from the annual or diurnal motors, and rotating at a speed of ten revolutions per planetarium year, is used for deriving the movement of the earth. It is not necessary to have a separate gear train for the earth movement in each cage, as the shaft of the earth wheel can be passed through the base plate into the adjoining cage. In this way Mercury and Venus, and Mars and Jupiter are connected in pairs.

The principle of the Mercury mechanism is shown in Fig. 4. Here the eccentricity of the orbit is such that the movement cannot be approximated sufficiently by a uniform circular motion with the sun's position offset from the centre. The gear train ends in wheel *N* which drives the planet wheel *S* through an intermediate wheel *Q*. This wheel has a radial slot in which both *N* and *S* engage by means of the sliders *P* and *R*. The desired movement is obtained by making the distance between the centres of wheels *N* and *Q*, and *Q* and *S*, equal to the eccentricity of the orbit of Mercury (reduced to the scale of the machine). The wheels *N*, *Q*, and *S* are supported on their edges each by three rollers mounted on ball bearings. The assembly is inclined to the axis of the ecliptic at the same angle as the plane of the orbit of Mercury to the plane of the orbit of the earth.

(To be continued)

Steel Roof Trusses

PREFABRICATION of light structural frameworks, for buildings such as storage sheds, schools, and so forth, is now extensively practised in structural steel. The various designs of these structures which are on the market generally offer a comprehensive range of roof spans, and considerable ingenuity has been shown in making them adaptable to very varied requirements, whilst maintaining standardised manufacture. Nevertheless, each of such standardised designs must aim primarily at certain specific objects; for instance, in last week's issue of THE ENGINEER we described just such a range of structures where economy in shipping space and simplicity of erection were primary aims. We have now received details of another system of this kind which, by contrast, has a less utilitarian approach, and has been devised with the aim of retaining the advantages of prefabrication, yet answering the criticism that buildings of this kind lack individuality in appearance; the system is therefore intended to provide a basic structure which will allow an architect to superimpose his own special treatment with considerable freedom. It has been introduced by Sherbourne Engineering, Ltd., under the trade name of "Select" structures.

Basically, these structures comprise a range of low-pitched Pratt trusses, built in welded tubular steel with bolted site connections. The pitch of the roof is 10 deg., which is considered to give good appearance and economy in heating the completed building. The trusses range from 16ft 8in to 40ft in span, in increments of 3ft 4in, which is the "module," truss panels also being 3ft 4in in length. The depth of the 40ft truss is about 5ft at the centre and 18in at the ends; two panels on each side of the centre are formed into one prefabricated unit which is bolted on to units on each side of it. Joint details involve welding on plates and other shapes so that the joints can be made with fishplates.

Steelwork is fabricated from hot finished welded steel tubing of round and rectangular section, in accordance with B.S. 1775, Grade 13 (all tubes are sealed) and is designed in accordance with B.S. 449 : 1948. Roofing comprises: (*a*) "Woodcemair" building slabs (wood wool impregnated and bonded under pressure) of either 2in or 3in thickness—slabs are reinforced longitudinally along both edges with tongued-and-grooved cold-rolled steel channels, rust-proofed by hot dip galvanising; (*b*) cement and sand screed of 4 : 1 mix ½in thick; (*c*) "built-up" roofing of felt and bitumen with an approved finish.

Productivity in the Iron and Steel Industry—1945-1956

By M. D. J. BRISBY

IN June, 1952, the Anglo-American Council of Productivity published *Iron and Steel*,[1] the report of a productivity team representing the British iron and steel industry which visited the United States of America in 1951. The report attributed the greater productivity in the American iron and steel industry to two main factors: larger production units and the higher rates at which plant is operated.

Much is read to-day of the need to increase output and reduce costs in order to maintain and improve our standard of living. Raising output in itself is not enough; to put it crudely, more must be got out of what is put in. Production as well as productivity must be raised. Productivity has been defined as a ratio, "being the output of a given product divided by the amount of any one of the resources which are together necessary to achieve that output."[2]

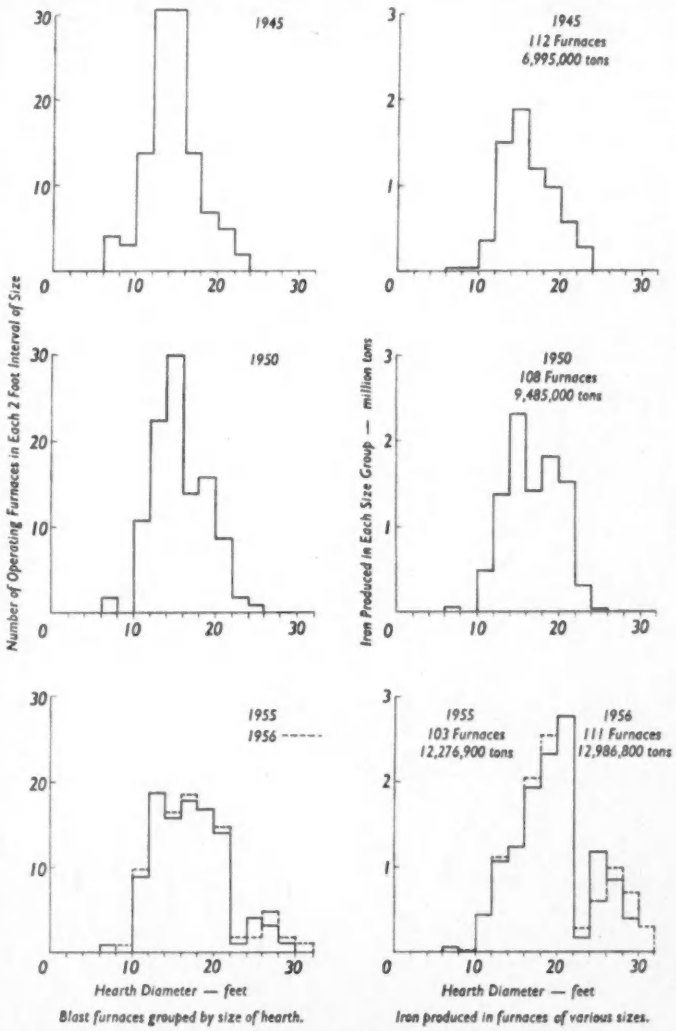
Productivity in the iron and steel industry in the United Kingdom has made considerable progress in the course of the last ten years. Pig iron production has risen from 7,100,000 tons in 1945 to 13,200,000 tons in 1956, but there are fewer furnaces in blast to-day than in 1945. Crude steel output has risen from 11,800,000 tons in 1945 to nearly 21,000,000 tons in 1956, with very little change in the total number of steelmaking furnaces. Despite this big increase in output, the total labour force in the industry has remained almost constant. To quote one instance, the number of men required to operate a 27ft hearth blast-furnace producing 350,000 tons a year is no greater than that required for a 14ft furnace producing 100,000 tons. Labour productivity or the output per man is therefore correspondingly higher. In 1945 the output of iron for every process worker employed in blast-furnace and sinter plants was 690 tons; by 1956 this had risen to 1113 tons.

A brief review of how some of these improvements were achieved will now be given.

Ironmaking

The improvements in blast-furnace operation are largely due to the bigger blast-furnace units which have been coming into operation in recent years and to the greater use of ore preparation. The diagram shows basic and foundry iron blast-furnaces grouped by size of hearth and the iron made. Blast-furnaces making ferro-alloys are not included. It will be seen that by 1950, although there was little change in the distribution of furnace sizes, more iron was already coming from larger furnaces. By 1956 there was a definite shift to larger furnaces and a further reduction in the proportion of iron coming from the smaller furnaces although many were still in use. The really big furnaces, although few in number, now produce a large proportion of the output of iron. Many of the small furnaces that remain are foundry iron furnaces and usually smaller than the basic iron furnaces providing iron for steelmaking. Four very large new blast-furnaces have been built since 1955: a 27ft hearth furnace at John Summers, two 27ft 6in furnaces at Dorman Long and a 29ft 9in furnace at the Steel Company of Wales. The recent enlargement to 31ft of "Queen Anne" at Appleby Frodingham now makes this the largest furnace in Europe and the second largest in the world.

This year the position will be considerably better than shown above. Ten new furnaces with hearths over 20ft in diameter will have been constructed, of these one will be a 30ft furnace and the others over 25ft 9in.



Blast-furnaces and iron production, 1945, 1950, 1955 and 1956. (Ferro-alloy furnaces and production not included)

Ore preparation has contributed in two ways to improving blast-furnace operation; by reducing the coke rate and especially by increasing the iron output. The table below shows that the consumption of coke per ton of iron produced has fallen by some 15 per cent since 1945.

	1945 cwts.	1950 cwts.	1955 cwts.	1956 cwts.
Coke charged to blast-furnace per ton of pig iron produced	23·0	20·5	19·6	19·7

Most works to-day prepare at least part of their burden and many operate comprehensive ore preparation plants with crushers, screens, bedding and blending plants and sintering machines. The advantages to be gained from charging sintered burdens into the blast-furnaces are well known[3] and will not be discussed here.

The increase in the use of sinter since 1945 is shown in Table I.

TABLE I—*The Use of Sinter in Iron Making*

	1945	1950	1956
Ironworks with sinter plants ...	13	13	17
Production of sinter (million tons)	2·5	3·3	7·7

Steelmaking

Developments in steelmaking have matched the improvements in blast-furnace operation. The increase in output of steel shown in Table II is due to the increase in size of furnaces and to the higher driving rates made possible by improved techniques such as conversion to oil firing, better handling facilities and services generally, and to the use of oxygen as a means of accelerating the melting and refining process.[4] Oxygen has been used successfully as a refining agent in place of iron ore and mill scale both in the open hearth and in the electric ore furnace.

TABLE II—*Crude Steel Production of all Qualities*
(In thousand tons)

	1945	1950	1955	1956
Open Hearth	10,185	14,292	17,252	18,003
Bessemer	857	1,094	1,284	1,308
Electric	542	736	1,099	1,198
Other and unclassified ...	240	171	156	150
Total	11,824	16,293	19,791	20,659

The mean rate of refining is accelerated when oxygen is used for decarburisation in the open hearth and this may lead to substantial economies in time and fuel. The open hearth has for many years been responsible for the bulk of Britain's steel output. Production by this process has increased by nearly 80 per cent between 1945 and 1956. The increase of 50 per cent in output of Bessemer steel over the same period is interesting in view of the fact that the increase came about prior to the development of oxygen-enriched and oxygen-steam blowing.[5] These new processes may well account for a substantial expansion of Bessemer steel in years to come. The increase in output of electric steel of over 100 per cent since 1945 has been achieved principally by the commissioning of larger arc furnaces. The output of 542,000 tons of electric steel in 1945 was made in some 220 furnaces. By 1956

TABLE III—*Production of Alloy Steel*
(In thousand tons)

	Total steel	Alloy steel only			
		Ingots	Castings	Total alloy	Percentage of total steel
1945	11,824	621	99	720	6·1
1950	16,293	801	93	894	5·5
1955	19,791	1,089	130	1,219	6·2
1956	20,659	1,153	136	1,289	6·25

the number of furnaces had risen only to 250, but output had gone up to nearly 1,200,000 tons.

The production of all qualities of alloy steels (electric and other) for the years 1945, 1950, 1955 and 1956 is shown in Table III. The share of alloy steels in total production at the end of the war was high because of military requirements.

Table IV gives the size distribution of the basic open hearth furnaces responsible for the greater part of Britain's steel output. The distribution, which is for the years 1945, 1950, 1955 and 1956, shows that the number of furnaces in the small size group (up to 100-ton

TABLE IV—*Basic Open-Hearth Furnace Size Distribution*

(Hot and Cold Metal Practice)

Furnace sizes (tons tapped)	Number of furnaces in each size group			
	1945	1950	1955	1956
Up to 40	12	14	10	8
41– 60	124	112	92	85
61– 80	57	75	60	64
81–100	47	70	72	61
	240	271	234	218
101–120	11	16	30	40
121–140	3	2	3	5
141–160	4	11	11	12
161–180	8	9	9	1
181–200	—	2	15	26
	26	40	68	84
201–250	13	12	19	17
251–300	4	8	8	8
301–350	—	1	2	2
351 and over	—	—	5	5
	17	21	34	32
Total number of furnaces	283	332	336	334
Total basic O.H. steel (million tons)	9·0	13·0	16·3	17·0
Average output a year per furnace (tons)	31,800	39,200	48,500	51,000

capacity) has decreased and that numbers have increased in the two groups of medium and large furnaces. The average yearly output of steel per furnace has gone up from 31,800 tons in 1945 to 51,000 tons in 1956. This year the position will be improved. There will be seven more furnaces in the range 181 tons to 200 tons and six more furnaces in the range 201 tons to 250 tons.

This increase in furnace size has been accompanied by harder furnace driving. Improvements in scrap preparation and in the supply services have led to quicker furnace charging, and this, together with provision for greater heat inputs, has reduced the time required to make each batch of steel.

A detailed study of basic open-hearth furnace productivity carried out by B.I.S.R.A.[6] shows that the furnace-week productivity or the output per furnace-week has gone up from about 975 tons in 1950 to 1258 tons in 1955, an increase of 29 per cent. Furnace availability or the percentage of the total time for which a furnace is available for use shows no improvement. This means that on average little or no progress has been made in speeding up major furnace repairs and rebuilds. On the other hand, utilisation or the percentage of the available time during which the furnace is actually used has improved from 93 per cent in 1950 to 97 per cent in 1955.

Furnace productivity has been helped by the large-scale introduction of oil firing in open-hearth steelmaking practice. In many furnaces, particularly those which have been enlarged beyond the capacity of the original flue system, the change to oil firing has permitted the driving of more heat into the furnaces. It will be seen from Table V that whereas in 1945 there were no oil-fired furnaces in Britain, in 1955 more than half the furnaces were equipped for oil or other liquid fuel firing. Almost all new furnaces have been designed for oil firing.

TABLE V—*Methods of Firing Open-Hearth Furnaces*

(Acid and Basic)

	1945	1950	1955
Furnaces equipped for oil or other liquid fuel firing	None	122*	197*
Furnaces fired by producer gas only	Most	252	192

* Many of these furnaces can also be fired by coke oven gas.

Much of the increase in output of steel has come from higher driving rates. A review of open-hearth furnace practice has shown that ninety-four open-hearth furnaces in the country have tapped one or more additional heats a week in 1955 than in 1950.

Number of Furnaces Tapping Additional Heats	Number of Additional Heats per Week
42	1
34	2
18	3 and 4

Despite the fact that furnaces have been driven harder, the fuel consumed in the manufacture of finished steel has decreased. The consumption figures for 1948, 1950, 1954, 1955 and 1956 are:—

	1948 cwts.	1950 cwts.	1954 cwts.	1955 cwts.	1956 cwts.
Estimated coal and coal equivalent of oil, coke and electricity consumed in steelworks to manufacture 1 ton of finished steel	37·9	35·0	34·1	34·4	32·9

Table VI shows the reduction in use of coal (other than coking coal), the greater use of oil and of other liquid fuels, and the increasing use of electricity in the industry.

TABLE VI—*Fuel Consumption in the Iron and Steel Industry Excluding Iron Foundries*

(Excluding Coking Coal, Coke and Coke Breeze)

	1948	1950	1954	1955	1956
In million tons:					
Coal	7·7	7·62	5·98	5·78	5·46
Fuel oil	0·68	0·80	1·21	1·42	1·55
Tar and creosote pitch	0·14	0·31	0·50	0·55	0·68
In thou. million cubic feet:					
Coke oven gas (consumed)	48·8	55·8	78·1	79·7	83·7
In million units:					
Electricity (used)	3631	4204	5365	5990	6296

Surveys conducted by the National Industrial Fuel Efficiency Service[7] at fourteen steel works in the country provide a good example of fuel savings achieved by installing new plant for waste heat recovery. The estimated savings in steam raising plants averaging nearly 27 per cent of consumption. The savings are the highest recorded for any industry in the United Kingdom.

Rolling Mills

It is impossible to find a ready method of evaluating the improved performance of rolling mills, as increased outputs may be due to a number of reasons and not infrequently to increased availability of steel. Rolling capacity especially at the finishing stages is normally in excess of crude steel capacity to allow the range of production to follow any change in demand. But after the war there was a surplus of mill capacity in the United Kingdom, and generally the greater outputs have been achieved by bringing steelmaking and rolling capacities into balance. Since 1950, major extensions and alterations have been made to numerous mills in the country, and a variety of new mills have been constructed. Of these the most important are five new primary mills, seven continuous billet, bar and rod mills, one continuous wide strip mill, four groups of multiple stand cold mills, a new section mill, three tube mills, and three planetary mills.

Labour Productivity

The larger and more efficient furnaces and harder driving rates, the new and reconstructed rolling mills and the reduction in the use of solid fuels have all contributed to increased labour productivity. The labour productivity figures for 1945, 1950, 1955 and 1956 for all workers employed including process workers, maintenance men and administrative, technical and clerical staffs in all sections of the industry are shown in Table VII.

TABLE VII—*Overall Labour Productivity*

Year	All workers employed (June)	Crude steel production/year, tons	Output per man-year, tons	Index
1948	286,000	14,880,550	52	100
1950	295,000	16,290,000	55	106
1955	302,000	19,790,000	65	125
1956	314,000	20,660,000	66	127

It will be seen that the overall labour productivity on the basis of crude steel output has risen by 27 per cent since 1948.

Conclusions

To-day nearly half the output of pig iron is made in furnaces with hearths of 20ft diameter and upwards and nearly all the projected furnaces are in the 25ft to 30ft diameter range. The accepted standard for fixed basic open-hearth steel furnaces is 200 tons capacity, new tilting furnaces are in the 300-ton range and electric arc furnaces with capacities of 60 tons and 80 tons are no longer exceptional. Continuous mills for rolling sheet strip, billets, small sections, bars and rods are now firmly accepted as the norm. In recent years, much greater rolling speeds have been achieved and there are mills to-day rolling twice the tonnage they were originally intended for. Despite the greater speeds, sheets, sections and plate are now produced to closer tolerances than ever before. Labour productivity in the industry, taken as a whole, has increased by 30 per cent since 1948 and is still steadily rising. These improvements are evidence that the challenge of the productivity team report is being met.

References

[1] Iron and Steel Productivity Team Report, June 1952, Anglo-American Council of Productivity, U.K. Section.
[2] Definition. Productivity Report. Appendix A(1), page 126.
[3] "Symposium on Sinter," Special Report No. 53, published by The Iron and Steel Institute, March, 1955.
[4] D. J. O. Brandt, "The Use of Gaseous Oxygen in Open Hearth and Converter Steelmaking," *The British Steelmaker*, November, 1954, pages 428–434.
[5] "the Relative Merits of Enrichment of the Blast with Oxygen or of Blowing with Oxygen and Steam," Joint Metallurgical Societies' Meeting, Europe, 1955, Centre National de Recherches Metallurgiques, Liège, June 13, 1955.
[6] "Basic Open-Hearth Furnace Productivity," 1955, B.I.S.R.A. Report No. SM/73/56.
[7] National Industrial Fuel Efficiency Service, Second Progress Survey, April 1, 1955–March 31, 1956.

Tyne Tunnel

MR. HAROLD WATKINSON, Minister of Transport and Civil Aviation, announced in the House of Commons recently his agreement in principle to the scheme for the Tyne tunnel, prepared by the Tyne Tunnel Joint Committee; he hopes to authorise it in the year 1958/59. The tunnel will be built near the present Jarrow–Howdon ferry and will be nearly 1 mile long. The combined length of the tunnel and approach roads will be 5 miles, and the total cost is estimated at nearly £13,000,000. The tunnel will be for the exclusive use of motor traffic and will have a single two-lane carriageway. Preliminary investigations have shown that the tunnel will have to be driven through difficult ground calling for advanced tunnelling methods. The approach roads will comprise two carriageways, each 24ft wide, and separate tracks for cyclists to link with the separate existing tunnel for cyclists. The tunnel is essentially similar to that described in THE ENGINEER of June 13, 1947. The consulting engineers for the scheme are Messrs. Mott, Hay and Anderson.

Atomic Energy Laboratories at Erith

Recent extensions of the research and development facilities of the G.E.C. Atomic Energy Division at Erith are described here. They include a new laboratory specially designed and equipped for studying the properties of fabricated beryllium and establishing safety codes and limits. An existing building has been adapted for use as a mechanical engineering laboratory and a structural laboratory has also been set up. The contracts and construction departments, with a staff of 450, are now housed in a new administration block.

ON a visit to the headquarters of the G.E.C. Atomic Energy Division at Erith, Kent, last week, we saw something of the substantial expansion that has been made in the research and development facilities of the division since our previous visit, about eighteen months ago (THE ENGINEER, August 24, 1956).

At the time this establishment was set up it was equipped initially to further the immediate aim of producing very quickly a complete design for the first stage of Great Britain's nuclear power stations, as typified by the installation that the G.E.C. is now building at Hunterston. Now the scope of the division's activities has spread considerably. The research and development effort is directed towards improving the design of the gas-cooled, graphite-moderated reactor, increasing its efficiency, lowering its costs, and adapting it to suit special requirements, particularly for the export market. Accordingly, new laboratories have been established and much new equipment has been installed in existing laboratories.

For example, there is a new laboratory which has been specially designed and equipped for work on beryllium—a metal which offers good prospects as a material for fuel cans suitable for use at temperatures of 600 deg. Cent. or more.

In another laboratory the prototype of a remote-controlled power manipulator has been made and is now undergoing its final tests. This manipulator, which is believed to be the first of its kind to be designed and built in Europe, is electrically operated and is controlled by one person from a movable console.

An existing building has been converted to accommodate a laboratory mainly for mechanical engineering work and another for experimental structural analysis.

A new administration block houses the contracts and construction departments. The company's Atomic Energy Division at Erith now employs a total staff of 450, compared with 200 less than two years ago.

BERYLLIUM LABORATORY

The beryllium research laboratory is designed for the study of the chemical and physical properties of beryllium in the fabricated form. Because of the toxic properties of small particles of beryllium, the layout, construction and equipment, including an elaborate ventilating system, have been planned with a view to maintaining a very high standard of safety in the use and handling of beryllium. A strict code of practice has been devised for all staff using the building and a system of regular and thorough medical examinations has been established.

Beryllium has many properties that are desirable in a fuel canning material for use in gas-cooled reactors, as can be seen from the accompanying table. Its neutron-absorption cross section is very low ; its melting point (1280 deg. Cent.) is much higher than that of metals now used for canning ; its resistance to oxidation is good in carbon dioxide, whether wet or dry, and its high-temperature strength is very good. Present knowledge suggests that a beryllium fuel can could probably be operated at temperatures of about 600 deg. Cent., which would allow the maximum gas temperature at the reactor outlet to be raised at least 100 deg. Cent. above current values, with a considerable gain in thermal efficiency.

However, there is a great deal of work to be done in defining the limiting conditions under which a fuel element canned in beryllium could be used. The first stages of the programme of work will include investigations on mechanical properties at elevated temperatures and measurements of oxidation resistance in carbon dioxide. One of the major disadvantages of beryllium is its brittleness, and it is intended to give special attention to this defect. Equipment for studying creep and stress-rupture is being installed. Other subjects for future work include the welding of beryllium and the examination of the effects of aqueous corrosion.

The Laboratory Building.—Methods of eliminating the hazards caused by the metal's toxicity have been fully investigated by interested authorities both in this country and in the U.S.A., and, as a result, a number of recommendations have been made. The standards adopted by the United Kingdom Atomic Energy Authority, and applied in the design of the new laboratory, stipulate a working atmosphere where the average atmospheric concentration of beryllium does not exceed two millionths of a gramme per cubic metre throughout the working day. To reach this standard, great care must be devoted to each operation involving beryllium and special techniques may be required in particular cases. For example, dusty operations, such as grinding, require more precautions and protective installation than some other, non-abrasive, operations.

The laboratory is a two-storey brick building with a concrete roof. Normally the only means of entry is through a change room, divided into two parts by a barrier. On the entry side of this barrier, outer garments are left in lockers; on the contact side laboratory clothing, including head- and foot-gear, is provided, and there are washing facilities and a shower. A washing machine complete with spin drier, and a drying cabinet are installed, as no clothing is sent out from the laboratory for laundering.

The laboratory is divided into two areas, *A* and *B* ; the area *A* is designed for operations of greater potential hazard, and has a higher air-extraction rate than the area *B*. Double emergency doors open out of the building from laboratory area *B* and these doors, though normally sealed, are also used where necessary for the introduction of plant and machinery. On the first floor are the service room and the extract-filter room, and some office and laboratory accommodation for the Medical Radiobiology Department.

The walls and ceiling are finished in a high-gloss paint. All the electric wiring is buried beneath the plaster, and all switches and sockets are flush fitting. The light shades are sealed to the ceiling to avoid dust traps.

The floor is covered with heavy-gauge linoleum, coved to the walls, and contains twenty-five drain points. Liquid effluent is discharged to a 400-gallon inspection and holding tank, which can be monitored. This tank acts as a water seal on the laboratory drains, so that air cannot be drawn into the building via the drainage system.

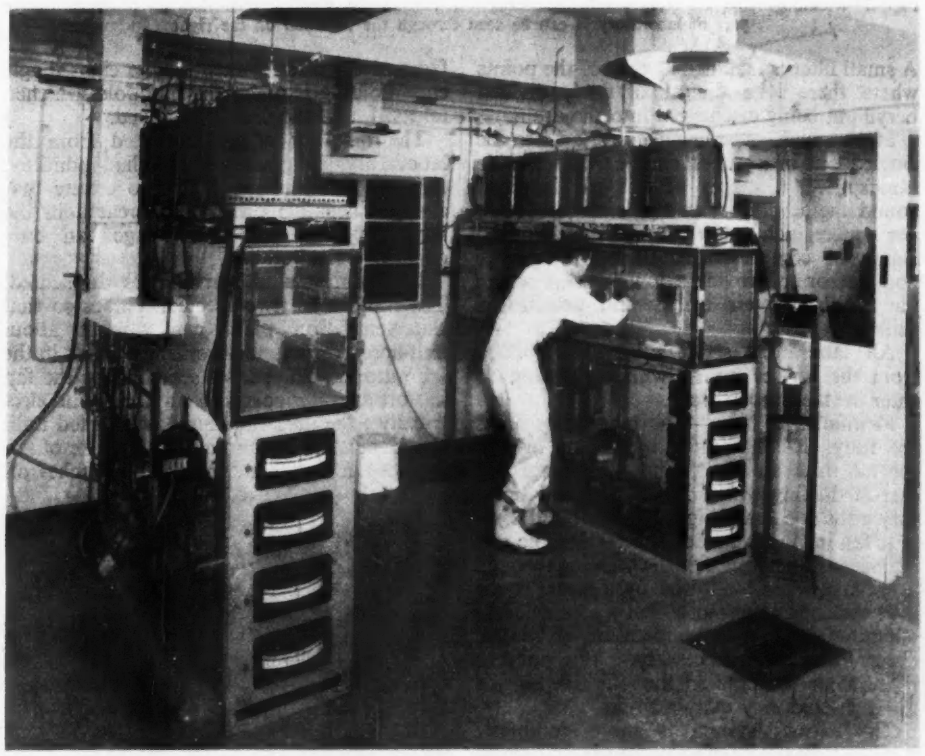


Fig. 1—Working boxes for experiments on oxidation and heat-treatment of beryllium. One of the air inlet points can be seen on the left. The extract ducting is along the wall

Fig. 2—Metallography box in beryllium laboratory A, with an air-sampling operation in progress (left); part of laboratory B can be seen through the partition on the right

A small filter is installed at each of the points where there is a danger of finely divided beryllium being discharged into the drain.

Since much experimental work is to be carried out in a pressurised carbon-dioxide atmosphere, a supply of this gas is piped round the laboratory at a pressure of 150 lb per square inch gauge. Besides the normal supply of compressed air there is a separate compressor to provide a low-pressure, clean air supply for air masks and pressurised suits.

All laboratory services can be isolated from the service room without having to enter the laboratory itself.

Ventilation System.—The laboratory areas are fully air-conditioned by means of one central inlet air duct, and two ranges of extract ducting which run along the laboratory walls at ceiling height. (Figs. 1 and 2.)

A fan having a capacity of 6000 cubic feet per minute draws air into the building through a bank of filters followed by a steam-to-air heat exchanger thermostatically controlled to maintain an inlet-air temperature of 75 deg. Fah. Filtration is necessary at this point in the system to increase the effective life of the high-efficiency extract filters.

The extract system is more complex; it consists basically of a fan drawing air at the rate of 8000 cubic feet per minute from the laboratory, through twelve Vokes "Absolute" filters, arranged in two banks of six, coupled in parallel to the extract fan. Each filter is individually mounted in a cell on the manifold, to minimise the hazard during filter changing. The "Absolute" filter has a guaranteed efficiency of 99·95 per cent removal of particles in the range 0·1 to 0·5 micron in diameter. For particle sizes greater than 1·0 micron, the efficiency of removal is virtually 100 per cent. The state of each filter is shown by a manometer.

The extract air is drawn from the laboratory through working boxes and hoods, which are coupled to the main extract ducts. The maximum linear air velocity in the main extract ducts is 1000ft per minute.

A filter can be changed with the ventilation plant running (Fig. 4): the filter cell is first isolated from the system by the insertion of blast plates above and below the cell. Two further blast plates are then inserted into the actual filter thus sealing both faces of the filter element. The eight toggle clips holding it on to the manifold are then released, and the filter is removed.

The quantity of air extracted from the laboratory is greater than that admitted through the inlet manifolds, to ensure that a slight negative pressure is created in the laboratory, so that air leakage can only occur into the building.

Fan motors and starters are duplicated. The motors are two-speed machines so that the ventilation plant can run at about half-speed during non-working periods in the laboratory. The starter switches for the fan motors are interlocked mechanically and electrically; the inlet fan cannot be started until the extract fan is running, and failure of the extract fan motor automatically switches off the inlet fan. Failure of the extract system initiates a visual and audible alarm.

Working Boxes.—Initially, all experimental procedures involving the handling of beryllium will be done in ventilated working boxes, each designed around a specific operation. All operations involving the formation of beryllium dust or chip (for example, machining, abrasion, and welding) are confined to the first laboratory (Fig. 3), where the highest ventilation rate is available.

There are two kinds of boxes. For experimental work at elevated temperatures, they are constructed from sheet metal, on an angle-iron frame. For general laboratory techniques, such as metallography, a "Perspex" hood is attached to a conventional bench. The interior of the hood is accessible through a "Perspex" working face. In this face there is a single hinged door, opening outwards, and a series of sliding doors. The hinged door provides a single maximum opening in the box, which can be subdivided by means of the sliding doors, while the total area of the openings is limited. For welding work, a glove box is used; access to this box is gained by means of arm-length rubber gloves sealed to the working face. This arrangement is, in fact, the familiar dry box, modified to accommodate a high air velocity.

Operating Procedure.—If all risks of beryllium poisoning are to be avoided, each laboratory operation must be proved safe before it is acceptable on a routine basis. Therefore, while a complete change of clothing, followed by a shower at the end of the day, is obligatory even for normal work in the laboratory, each new operation is initially performed in fully protective clothing with an external air line. Using this procedure, any operation can be carried out while air samples are taken at a number of points near the operator to determine whether the operation can be conducted safely, that is without approaching the maximum permissible level for atmospheric beryllium concentration. Once this has been established the work can be continued without an air

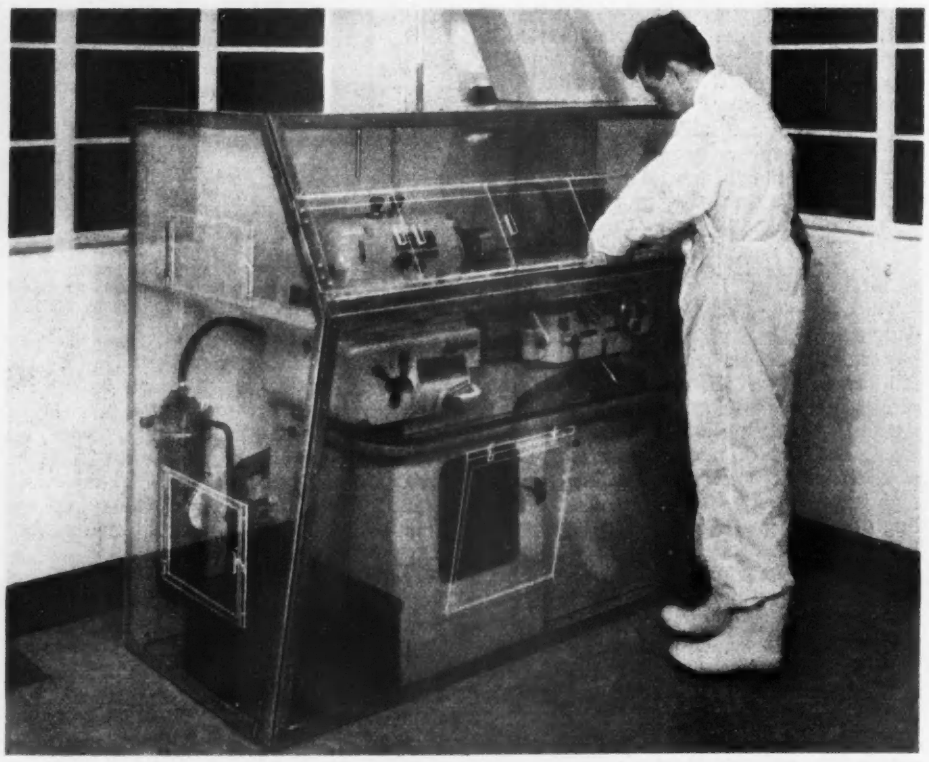


Fig. 3—Lathe enclosed in "Perspex" working box, installed in the more highly ventilated area A of the beryllium laboratory

line or the associated protective clothing.

Beryllium monitoring is difficult, and, at present, the use of spectro-chemical techniques on a batch-sampling basis provides the best safeguard. In collaboration with the G.E.C. Research Laboratories at Wembley, a sampling and analytical scheme (providing normally a twenty-four hour service) has been established using air samples of about 10 cubic metres. By the methods employed, as little as 0·015 millionths of a gramme of beryllium can be detected.

In addition to air monitoring on specific operations, routine background samples are taken daily in the laboratory over a period of eight hours. Additional monitoring is employed for any unusual circumstances, such as swabbing down machines, or for any minor spills; on these occasions fully protective clothing is worn.

Beryllium Storage.—A fireproof safe is used as a store in which all beryllium is kept when not in use and when the laboratory is closed. Solid waste contaminated with beryllium will be disposed of in the same way as that adopted by the U.K. Atomic Energy Authority, that is by burial in sealed containers.

Mechanical Engineering Laboratory

Part of the ground floor of a building adjoining the main laboratories of the Atomic Energy Division has been converted into a laboratory for engineering research and development. It is intended mainly for work on mechanical engineering problems, but it also accommodates a number of rigs for heat-transfer research, and there is a welding bay at one end.

Reactor Model.—An interesting piece of apparatus in this laboratory is a one-twentieth scale model (Fig. 5) of a power reactor of the kind being built at Hunterston. It is used to carry out investigations on the flow of coolant gas within the reactor. A 42in diameter "Perspex" sphere houses a model of the reactor core in a scale-replica of the reactor pressure vessel, complete with its supporting skirt and its rings of inlet and outlet ports. The model of the core is made of "Duralumin," and rests on an "egg-box" support-grid similar to that used in the actual reactor. The vertical fuel and control-rod channels through the core are represented by tubes of a number and diameter such that the core as a whole offers a resistance to gas flow simulating that in the full-scale structure.

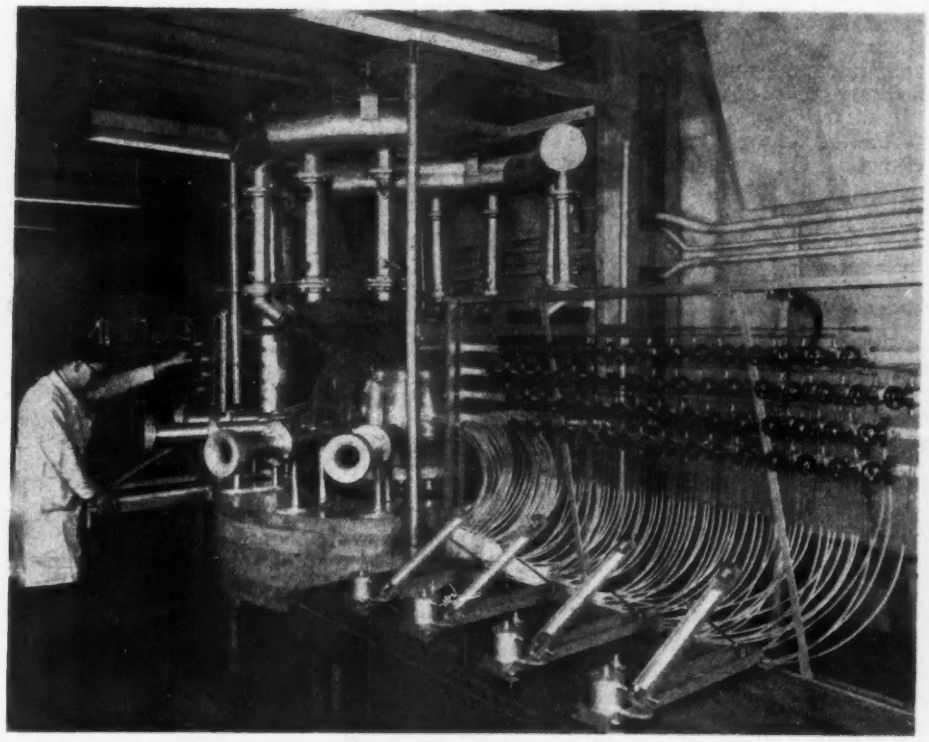


Fig. 5—Reactor model (1/20 scale) for gas-flow measurements in the mechanical engineering laboratory

A motor-driven blower, coupled to the outlet ports in the "Perspex" sphere, draws air through the model to simulate the flow of coolant gas in the reactor. Measurements are made of the flow of air at the inlet and outlet ports and of the pressure drop along selected channels through the core. Thus, the symmetry of the gas flow through the reactor can be examined, as can the effect of shut-down of one or more of the eight gas circuits which connect the reactor vessel to the steam-raising units. The influence of "gags" to restrict the flow of gas through the channels can also be determined.

Fuel-Element Insertion Tests.—When a fuel element is inserted into the reactor core during a charging operation, it is subjected to a considerable and relatively abrupt rise in temperature. A test rig has been built to ensure that the thermal shock resulting from the insertion of a fuel element into the reactor core during a charging operation has no deleterious effect on the structure of the fuel element. The rig is a horizontal cylindrical channel, 14ft long and having a bore of 6in, filled with carbon dioxide at a pressure of 150 lb per square inch gauge. A length of this channel at one end is heated by two 5kW resistance heating elements supported on refractory-cement sleeves. These elements are arranged end-to-end so that, by varying separately the supplies to the two heaters, the temperature gradient over the heated length can be varied.

The complete fuel element under test is mounted on a carriage which can be moved along the channel, into the heated zone, by a chain driven by a handwheel, whereby the effects of different rates of insertion can be studied for various temperature gradients on the element.

Transient-Temperature Tests on Reactor Support Skirts.—The spherical pressure vessel of the present G.E.C. design of power reactor is supported by a cylindrical skirt welded to the vessel. To prove that no excessive stresses are set up, particularly in the vicinity of the skirt-to-shell weld, it is desirable to study the effects on this skirt of sudden changes in the temperature of the coolant gas. Accordingly, a one-third scale model of a section of pressure vessel and skirt has been built. The model is mounted in a sheet steel enclosure encased in firebrick, and a motor-driven blower circulates carbon dioxide over its surface to simulate the gas flow in the reactor. The gas is heated by a 20kW electric heater, with a controllable input, to give the required variations in gas temperature. The gas velocities and temperatures in the model have been calculated to produce effects equivalent to those that will be

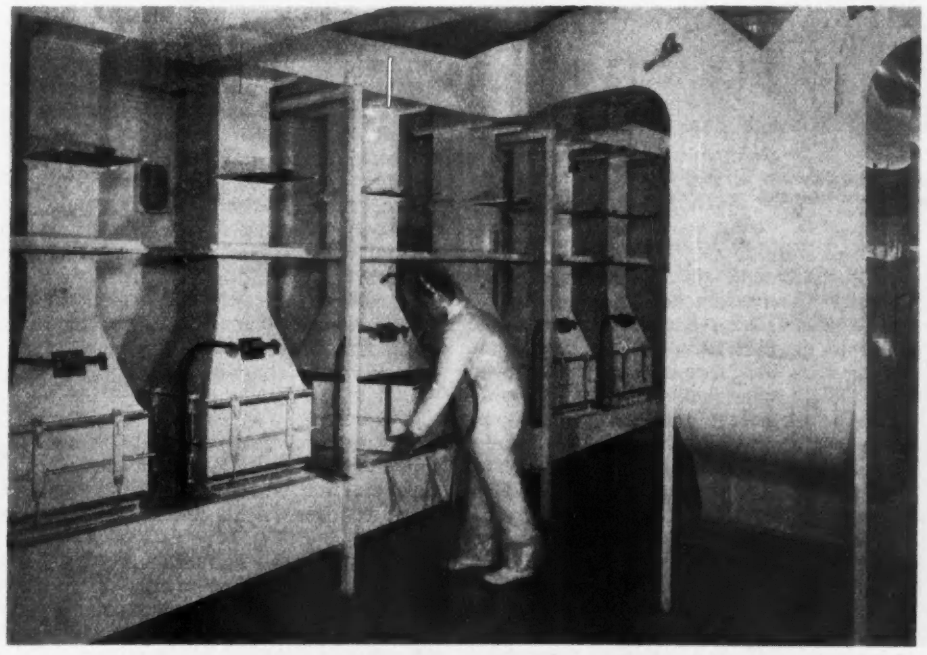


Fig. 4—One of the two banks of exhaust filters in the beryllium laboratory, with an operator in a pressurised suit changing a filter

experienced in the full-scale structure. The temperatures at various points on the model are measured by means of thermocouples and are recorded on a sixteen-way recorder.

Leak Testing of Steam-Raising Unit Tubes.—A method of works testing for leaks in tube elements of steam-raising units has been developed in which the tubes are partially evacuated and then immersed in hydrogen. Leakages of hydrogen into the tubes are detected by the Pirani method, based on the measurement of the thermal conductivity of the gas in the tubes.

One means of leak detection for complete installed units which is at present being investigated in the laboratory involves the use of a probe inserted into the header of the tube bank under test. The head of this probe, in which is located a small gas intake, is positioned above the end of each tube in the bank in turn and, at the same time, is isolated from all other tubes by means of an inflatable rubber seal. Any gas leaking into the tube is drawn into the probe head and is thence circulated through a mass flowmeter. This instrument not only indicates the existence of a leak but also provides a means of estimating its approximate extent.

electric heater is inserted in the bore. The complete element is enclosed in a pressure vessel containing " Dowtherm," which boils at about 450 deg. Cent. with a vapour pressure of 150 lb per square inch gauge. These are the temperature and pressure conditions that will exist within the reactor, and the use of " Dowtherm " therefore eliminates the need for a comparatively complex system for supplying pressurised gas to the apparatus. Continuous refluxing of the " Dowtherm " is obtained by providing a small condenser in the top of the pressure vessel. Thermocouples are provided to measure the temperatures at various points in the uranium and in the fuel can.

Bearing and Shaft-Seal Tests.—Certain items of equipment that were originally housed in the heat laboratory have been transferred to the new mechanical engineering laboratory. They include rigs for the testing of bearings and shaft seals under reactor operating conditions.

The bearing rigs are designed to investigate the performance of different kinds of bearing when running in pressurised carbon dioxide at various temperatures. In each unit (Fig. 6) two bearings are mounted on a shaft

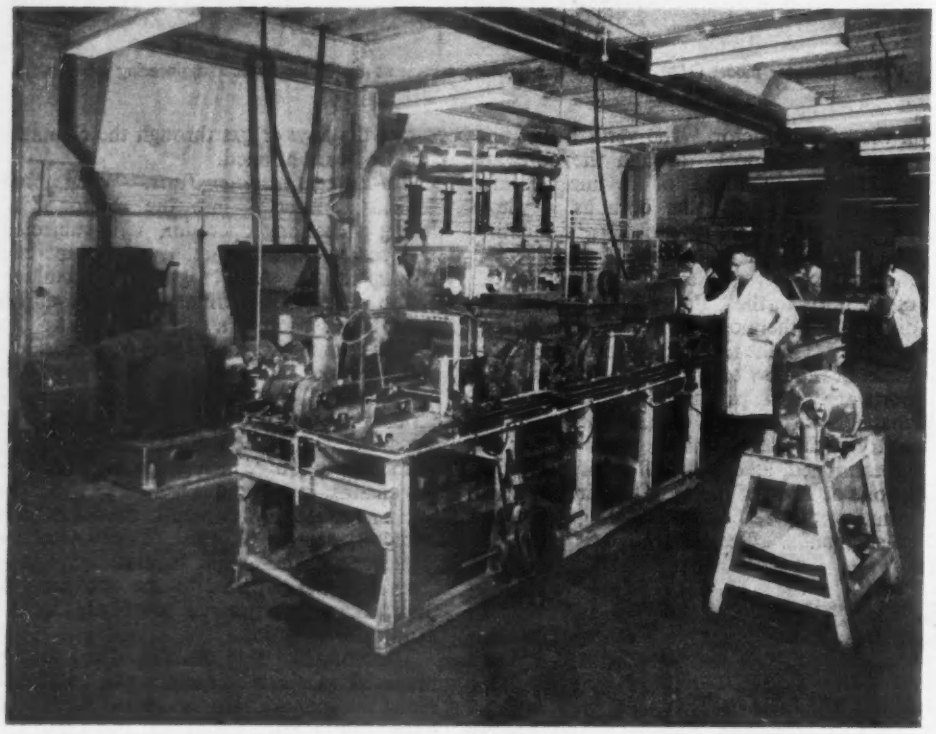


Fig. 6—Mechanical engineering laboratory. Three bearing test rigs can be seen in the foreground. The man on the extreme right is making an adjustment to the thermal shock test rig

Uranium-to-Can Heat Transfer.—Two test rigs are being used in the laboratory to measure the heat transfer characteristics which determine the temperature drop between uranium and the metal can enclosing it : this drop can be determined only by experiment.

In one rig, which is used for basic research work, discs of uranium and of the canning material are arranged face-to-face. One face is then heated and thermocouples are used to determine the temperature distribution along the heat path through the discs. In this way the effect of using different canning materials, different surface finishes and different gases to fill the small residual spaces in the can, may be determined.

The second apparatus is used for tests on complete fuel elements. So that the uranium can be raised to the temperature it will attain in the reactor, it is made tubular and an which runs inside a cylinder containing carbon dioxide, under pressure and electrically heated. The bearing housings are fixed to the cylinder walls, so that the frictional torque tends to drag the cylinder round with the shaft. This tendency is prevented by an adjustable counterbalance weight, the position of which gives a measure of the frictional torque. Weights attached to the cylinder serve to load the bearings. Temperatures are continuously recorded by means of thermocouples and chart recorders, while the frictional torque, bearing wear and shaft wear are measured at frequent intervals.

Various bearings have been investigated, including some employing graphite in a number of forms and mixtures, and others using various kinds of plastics. The effects of different shaft finishes have also been examined. In particular, two kinds of shaft seal have been extensively investigated. One is the " Flexibox " seal, consisting essentially of a carbon ring rubbing against a lapped steel surface, and the other is a viscous seal using oil as the sealing medium. Active development work on both is in progress.

Welding Bay.—Much attention has been given to the quality of welding. The welding bay in the new laboratory is equipped for any kind of hand welding operation and for experiments with a number of semi-automatic processes. The work of the welding group falls roughly into three fields—research and development on welding processes in general, specific problems arising from reactor design, and general welding as a laboratory service.

The first category includes comparatively routine acceptance and development tests on different kinds of electrode as well as experimental work on new welding processes. For example, the limit to the temperature gradient that can be set up in the metal pieces is being investigated. Experiments are also being carried out on dilution, i.e. on the relative mixing of the constituents of the base metal and the deposited weld metal.

The Heat Laboratory

It will be recalled (The Engineer, January 15, 1957) that the heat laboratory is one of the original laboratories of the G.E.C. Atomic Energy Division. Several items of experimental equipment that were installed when it was first established are still being used for work on advanced reactor designs. But because of the end of certain studies and the transference of some of the test rigs to the new mechanical engineering laboratory, it has been possible to install additional apparatus to meet the requirements of the expanding research programme.

Heat Transfer from Fuel Cans.—Much experimental work has been devoted to investigating the heat-transfer characteristics of various kinds of fuel can. As in the early stages of this work, the main apparatus used is one in which the measurements of heat-transfer coefficients and friction factors are carried out on the can in carbon dioxide under conditions of temperature and pressure similar to those that will apply in the reactor. Other experimental work can be done in similar equipments using air at atmospheric pressure as the cooling medium. Two of these air rigs are now installed in the laboratory, one operating on forced draught and the other on induced draught. Because these rigs are comparatively simple and quick to use they are useful for obtaining a rapid and broad assessment of the performance of fuel element cans.

Heat Transfer in Steam-Raising Units.—The heat-transfer characteristics of extended surface tubing for steam-raising units are assessed by passing dry superheated steam through the tubes and measuring the amount of steam condensed when a current of cooling air is directed over the tube bank. A new " wind tunnel " (capable of a greater range of air mass flow) for this work has recently been installed alongside the original apparatus.

Water Models.—Useful information on the performance of fuel cans and steam-raising unit tubes can be obtained by observing the flow patterns when water, instead of gas, is passed over the finned surface of the can or tube.

For experiments on fuel elements, a simple apparatus is used in which water flows longitudinally over a full-scale fuel can mounted in a transparent cylindrical channel. By injecting a marker dye or suspension into the water, the pattern of flow around the fins can be readily observed and photographed.

The equivalent apparatus for work on steam-raising unit tubes comprises a horizontal rectangular "Perspex" channel in which models of the tubes under investigation are mounted vertically so that the water flow is at right angles to their axes. The markers used in the water are small particles of polystyrene. By illuminating the channel from the side and mounting a camera above it, photographs of the tracks of the particles can be obtained. The length of each track indicates the distance moved by a particular particle during the time of the exposure and therefore provides a means of measuring the velocity of flow at different points in the system.

The "Hot-Box" Rig.—A useful addition to the equipment of the heat laboratory is a full-size model of one of the standpipes which connect the top of the reactor pressure vessel with the upper face of the concrete shield above it. These standpipes provide the means of access by which the control rods enter the core, the necessary driving mechanisms being housed in chambers mounted on top of the pipes.

The test rig, commonly known as the "hot-box," is connected at its lower end to an electrically heated pressure vessel which can be filled with either air or carbon dioxide. By this means, the conditions of atmosphere, temperature and pressure that exist within an actual standpipe can be reproduced inside the model. It is therefore possible to carry out full tests under operating conditions on any equipment that operates inside, or is connected to, a top reactor standpipe. Control rod mechanisms, the multi-way valves used in the burst-slug detection equipment, and other smaller items, can be so tested.

Permeability Tests on Graphite Sleeves.—In G.E.C. power reactors of the kind being built at Hunterston, the fuel elements are individually supported inside relatively large bore graphite sleeves, through which the carbon-dioxide coolant flows. Since, in general, graphite is permeable to gas, it was necessary to find the permeability of the graphite sleeves to carbon dioxide and then to adjust it to such a value that a stable system of gas flow could be produced.

Much of the work on this problem has been carried out at the G.E.C. Research Laboratories at Wembley, but experiments are at present being done in the heat laboratory at Erith to measure the permeability constant for Reactor Grade A graphite sleeves.

The apparatus employed consists of a pressure vessel in which a graphite sleeve is enclosed. Carbon dioxide, at the operating pressure for the reactor, is supplied to the centre of the sleeve and allowed to pass through it and out to atmosphere through a valve. The inlet flow rate, the pressure and the temperature of the gas are measured, together with the pressure differential across the sleeve. From these values the permeability constant under closely simulated operating conditions can be calculated.

Appointments

The General Electric Company states that Mr. R. N. Millar (who has been manager of the G.E.C. Atomic Energy Division since its formation, three years ago) will, from April 1, be appointed general manager of the company's Fraser and Chalmers Engineering Works at Erith. Mr. Millar will remain responsible for the company's atomic energy activities and he will be assisted in this field by Dr. K. J. Wootton, who will succeed him as manager of the G.E.C. Atomic Energy Division.

Education of Boys and Girls

The Association of Teachers in Technical Institutions has just submitted a memorandum to the Central Advisory Council for Education on the education of children between the ages of fifteen and eighteen. In fact, the memorandum covers more ground than that, since it discusses education in the schools. Amongst other matters the memorandum advocates an expansion in the provision of secondary technical schools; a major shift of emphasis from "arts" to "science" in grammar school curricula; a degree of vocational "flavour" in education from thirteen onwards; and compulsory part-time day education up to eighteen for all not receiving full-time education. Below we print extracts from the memorandum.

Size of Classes

THERE is a tendency in some quarters to think that Britain can solve her industrial and economic problems by concentrating her main attention in education on a slightly enlarged *élite*. In our opinion nothing could be more mistaken. The achievement of the expansion proposed at the other end of the educational system will depend ultimately on the development by the schools of the full potentialities of all the children passing through them. Under present conditions this is impossible. We shall be sparing in our reference to priorities, but here we are emphatic in urging that a substantial reduction in the size of classes must be achieved by the beginning of the decade 1965–1975.

The Secondary Technical School

Although the forms of secondary education provided under the tripartite system and its variants will continue to develop in the future, it is unlikely that any precise and final pattern will emerge in the period under review. Nevertheless, this Association believes that there is immediate need for one large-scale development which would constitute almost a reversal of present policy, namely, a considerable expansion in the provision of secondary technical schools. We believe that the secondary technical school which provides a "liberal education with science and its applications as the core and inspiration" is particularly fitted to serve a much larger proportion of the nation's children, including the more gifted, than is at present the case, in a scientific age which will influence their lives far more than our own. In 1956 under 96,000 boys and girls out of a total of over 2,000,000 were receiving secondary education in technical schools—that is, less than 5 per cent. Before 1975 the provision of technical and commercial school places should be increased at least fourfold to bring it approximately into numerical parity with grammar school provision.

We make this recommendation for several reasons. The first is particular and related to national needs. Given the opportunity this type of school could assist substantially in the diversion of a higher proportion of the more able pupils into technology. (It is therefore important that every secondary technical school should be encouraged to develop sixth forms for pupils having the inclination and ability to proceed to courses in advanced technology and commerce.) More generally, we are satisfied that the secondary technical schools (and here we use the word "technical" in its broad sense) provide a stronger bridge between the school and the world outside than other types of secondary school and are more likely to adapt themselves to the rapidly changing pattern of a dynamic society. It is assumed that a suitable proportion of the staffs of such schools will have spent some time in industry or commerce.

We believe, too, that the secondary technical school, properly encouraged and developed, could serve as a valuable pathfinder for all secondary education. Vocational motivation, judiciously introduced, has a powerful incentive value. Many secondary modern schools recognise the importance of this factor. Grammar schools have tended, on the whole, to stand aloof. For the many children who respond to this element in their education, interest is stimulated and performance improved. We support this approach to the curriculum not for its utilitarian value, but because of its influence on attitude to learning. In our view, therefore, the technical school could make a major contribution to a raising of standards of education in the entire secondary field and, at the same time, play a unique part in working out a pattern of education more relevant to this modern age.

Curriculum Matters

Our primary concern under this head is to emphasise the considerable need for more and better teaching of science subjects, and particularly applied science, in all schools. Our national economy depends upon applied science and technology. There is an ever-growing demand for scientists, technologists, technicians and craftsmen. New industries and new crafts are springing up, old industries are being mechanised and old crafts modified by the impact of a scientific revolution which influences and will influence, more and more, every facet of our lives, national and local, public and private. We question whether the traditional pattern of curricula in our schools is equal to these developments. There are two main issues as we see the problem, viz. (*a*) the grammar school curriculum, and (*b*) the supply of teachers of mathematics and science in all schools.

The Grammar School Curriculum.—Here we are convinced that nothing short of a major shift of emphasis from "Arts" to "Sciences" will meet the crisis which faces us. In 1956 there were 8900 graduate men and women teachers of mathematics and all sciences in maintained and direct grant grammar schools in England and Wales, but there were over 2000 graduate teachers of dead languages. In the summer of 1956 almost 40,000 boys and girls sat G.C.E. Latin at ordinary level; 36,000 sat chemistry. Too many of our most able boys and girls are being forced to devote themselves to intellectual studies which have no relation to this modern age. From ten to fifteen periods per week (out of thirty-five) devoted to two or three foreign languages, including one or even two classical languages with about five periods per week devoted to a "snippet" treatment of general science for any thirteen- to fourteen-year-old children, other than a minority, is not likely to yield a balanced curriculum.

Let it be clear that this is not a revolt against culture. It is a revolt against a limited culture dominated by the glory of Greece and the grandeur of Rome and reflecting little of the achievement, the ideas

and the philosophy of modern science. Nor is it a plea for the production of science barbarians. We wish to see evolved a curriculum which nurtures all that is good in our human and national heritage and which therefore also reflects the importance of science in mid-twentieth century. Simply stated, we wish to see the removal of Latin and Greek from the timetables of all but a minority of pupils and the time devoted to a broad treatment of science and its applications.

The Supply of Teachers of Mathematics and Sciences in Schools.—Only the united efforts of the Ministry of Education, local authorities, the area training organisations and the schools, with the co-operation of industry, will produce teachers of these subjects in the numbers required to meet the demands of the bulge and of the expansion of science teaching which we believe to be necessary in the grammar schools. It is equally important that more attention should be given to these subjects in secondary technical and modern schools and even primary schools.

Specialisation

We are completely opposed to premature specialisation or excessive specialisation at any stage in full-time education. Our view is that provision for vocational predilection, i.e. vocational " flavour," is appropriate at about 13+. Vocational commitment with consequent subject specialisation should be as late as possible and certainly not before the age of fifteen. This view supports the case for sixth forms in secondary technical schools. At the first stage, creation of interest and discovery of aptitude are the goals. (How can a boy be attracted to engineering, for example, except by being encouraged to explore some of the typical activities associated with engineering ?).

The selection of subjects for the major concentration of the pupil in the grammar school presents many difficulties. The system is bedevilled at the fifth form leaving stage by the variety of requirements of multitudinous professional bodies and at the sixth form leaving stage by the varied requirements of universities, their faculties and colleges. There is need for some rationalisation of their demands by the professional bodies. Specialisation in the sixth forms in relation to university entrance requirements has been the subject of much discussion of recent years. Here we hold the view that greater flexibility, particularly in faculty requirements, and some moderation of standards of admission is necessary if the sixth form pupil is to be given the opportunity of enjoying a broad education while giving special attention to a chosen field of study. Here we would make the point that enlightened and even inspired teaching of ancillary subjects is just as important as it is for main or examination subjects. The ultimate effect of a relaxation of standards of entry to the universities may be to increase the duration of undergraduate study from three to four years.

Duration of Full-Time Education

In 1952 about 7 per cent of each age group remained at schools until the pre-university year. By 1956 this figure had risen to 9 per cent, and if the present trend continues it will rise to 15 per cent by 1966 or 1967. We appreciate the intrinsic benefit to be derived from advanced work and the opportunities for wider training through two years in the sixth forms, but we suspect that even at the present time many boys and girls are specialising in grammar school sixth forms on work which will not best prepare them for their own future success in employment or for the country's needs, and many of them would be better catered for in strong sixth forms of secondary technical schools or, in some cases, in full-time or sandwich courses in technical colleges.

There should be no undue pressure, then, on pupils to embark on sixth form studies and, as we see it, it is unwise to encourage a boy or girl to do so if the university training college or advanced technology route is not appropriate to a chosen career and there is a clearly defined route elsewhere. Sixth form work in secondary technical schools, full-time or sandwich courses in technical colleges or even employment through student apprenticeship with part-time education may be more appropriate for a particular career or more suitable for those young people whose outlook is practical and who respond best to studies, not by any means narrowly vocational, but strongly associated with industrial or commercial applications and experience.

The Raising of the School-Leaving Age

We have given careful thought to the question of the raising of the minimum school-leaving age. Whilst we support the need in general principle, we are of the opinion that this step should be deferred until other reforms which we recommend (reduction in size of classes and compulsory part-time day education) have been effected. We summarise below our reasons for this view :

(*a*) By 1965 substantial progress should have been made in the reduction of the size of classes and three-year training of teachers should begin to have marked influence on the quality of the work in the schools. Resulting improved standards will make the raising of the leaving age more fruitful.

(*b*) Establishment of a full four-year period of secondary education, by removal of terminal leaving, and an increase in the number of pupils who voluntarily remain at school beyond the statutory age will produce a better climate for legislation. Indeed, the greater this trend becomes the less the need for compulsion.

(*c*) The expansion of part-time day release education is a more fertile field of development. Many pupils who have not profited fully by full-time schooling, or who wish to leave school as early as possible, often discover the value of and a liking for further study after transfer to employment and part-time education. The preference for part-time education is analogous with that of students of higher academic ability for the association of study with work in sandwich courses over sixth form or university studies.

(*d*) Part-time day release education for all young people between the ages of fifteen and eighteen can be secured in successive stages and is likely to provide the best return for the expenditure involved.

Extension of Part-Time Day Release Education

Of paramount importance in educational development during the next ten years will be the establishment of compulsory part-time day education for all young people between the ages of fifteen and eighteen who are not receiving full-time education. We are completely in favour of this long overdue measure. The growth of part-time day release for technical education has been spectacular in industrial and professional employment associated with apprenticeship. Except in a few isolated cases of enlightened firms releasing their young employees for county college type of education there has been little provision for young people in other types of employment.

Assuming the early introduction of compulsory day release, and noting the Government's proposal that the number of young workers released by their employers in the day for vocational education should be doubled within the next five years, we suggest that one issue is of fundamental importance, namely, the provision of technical education for the numerous groups of young people for whom it is both desirable and possible, but for whom there is little or no provision at present. There are whole industries in which technical education for adolescents is an urgent need and where it is at present confined to a small minority. An example is agriculture, where scientific progress and mechanisation demand technical education more and more, and yet only a relatively small number of workers in most areas attend farm institutes or other technical courses. The commercial side of industry, also, has neglected shamefully part-time day release education. The field of transport and distribution is largely unexplored from this standpoint. It has been too readily assumed that there is no appropriate technical course for workers engaged in repetitive processes, e.g. non-apprenticed machine operators.

The principle we would emphasise is that whilst further general education is highly important, its value will be powerfully enhanced by the introduction of the vocational element. In some of the examples we have quoted, the technical element should predominate, as it does in most existing part-time courses. In others, maximum advantage should be taken of it to buttress and illuminate general studies and to stimulate both interest and ambition. Another provision which we believe is worthy of development is the extension of release from work beyond a single day each week. In some courses there is a case for an extension of release to one and a half to two days, especially where there are comprehensive laboratory programmes and also where some time is taken up by formal liberal studies. A number of professional courses at the intermediate and final stages involve programmes of study for which attendance on one day, supported by one or even two evenings, is quite inadequate.

Finally, in this section we would like to make the recommendation based on the experience of some of our members that every part-time student should have the opportunity at least once between the ages of fifteen and eighteen of attending a short residential course. Reports suggest that where students have been given this privilege, results have fully justified the effort and cost. The practice should spread.

Transfer

Within the framework of further education provision we wish to see worked out a much more flexible system of transfer from one type of course to another. The need to develop to the full the capacities of all young people in industry and commerce, the need to persuade them to raise their " sights," the need to encourage and exploit late development, the value of craft experience in the spheres of design and management, the need to provide for fluctuations in industrial requirements are all factors which make it essential that courses and procedures should render upward transfer from craftsman grade to technician or technologist level as smooth as possible.

There is the converse problem of downward transfer. Much wastage in the past would have been avoided if this need had been recognised. Parents and students must be persuaded that craft skill is a national as well as a personal asset and success in a craft course is preferable to a laboured and finally unsuccessful pursuit of a higher qualification.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

RAILWAYS INTO ROADWAYS

SIR,—In your leading article on this subject, issue of January 31, 1958, among your many words of wisdom I recall two particular phrases which seem apposite while considering the letters in your correspondence columns on this subject. You say : " Examination indicates that his proposal is neither so nonsensical that Brigadier Lloyd can be labelled a ' crank ' nor so obviously faulty that . . . . . it can be ' shot down ' by an appeal to elementary facts." You also say, " . . . a revolutionary idea repulsive to every railway enthusiast."

These words of wisdom seem to have escaped the notice of your four correspondents, Messrs. Brindell, Clayton, Thompson and Tuplin, as have your further comments : " What he [Brigadier Lloyd] claims merits close attention." . . . . . " His arguments cannot be countered by didactic statements that railways are ideally suited to carry bulk freight, to carry passengers at high speeds over long distances or to collect and deliver large numbers of commuters daily." I hope you will accept as a graceful compliment my quoting from your leader, as I am aware I could not have put my case so admirably in reply to most of the points made by these four, presumably engineers.

May I make just three comments ? Mr. Thompson infers that the railway beds are too narrow for roads. Has Mr. Thompson compared the mileage of railway beds suitable for converting without widening to that of the existing mileage of dual carriageway, three-lane and two-lane rural, trunk and Class I highways in the country. Your readers may care to know that the equivalents are approximately :

	Rural, trunk and Class I highways, miles	Existing railbeds, miles
14ft to 19ft	4,400	7,750
20ft to 29ft	13,400	—
24ft to 29ft	—	10,300
30ft to 39ft	2,000	—
40ft and wider	200	1,950
	20,000	20,000

So by converting the railways we can at least double the whole of our existing important and much-used roads !

Let us suppose that even in many circumstances the existing railway bed is too narrow for an adequate conversion into a controlled road ; which does Mr. Thompson hold will be the greater difficulty and cause the greater upset and hardship to property owners, not to mention cost ; to drive a new road right of way through town and country or widen the existing right of way at present being enjoyed by the railways ?

Mr. Tuplin may be interested to know that shortly before the War I tested the virtues of the German autobahns with these results : it was voted by my four passengers that they found the steady 75 m.p.h. we maintained for some 60 miles or so far less fatiguing than any first-class travel on British main lines. What did impress them, no doubt as the result of experiences in dining cars, was that we were able to pour out full cups of coffee which were standing on the occasional tables in the car without a drop being spilled while we kept up a steady 75 m.p.h. ! My car cost under £600 new in those days. Road and vehicle engineering has improved since, and one cannot help wondering what sort of roads and vehicles Mr. Tuplin envisages which would engender that " sensuous pleasure of bouncing on rubber and air." For an experience of real discomfort in travel Mr. Tuplin should try some of our " modern " electric express trains from Waterloo to Portsmouth ! Many people seem to agree with the view that it can best be described as a pre-taste of hell !

Mr. Tuplin asks how many millions could be " saved " by merely prohibiting parking ? His guess is as good as mine, and I would only remark that one of the time-honoured ways of dealing with locusts is to keep them on the wing ! But perhaps Mr. Tuplin feels towards road vehicles as most people feel towards locusts ! One wonders what it would " cost " the nation to drive the vehicles off the roads !

I am not sure what Mr. Brindle is trying to say in his statistics on deaths and accidents, but may I suggest to him that there is little virtue in being able to point to a low accident rate on railways if by converting them to a system of controlled roadways the overall total of deaths due to traffic movement could be reduced by some thousands. Is it not reasonable to expect that with the frightful road conditions in this country, if the U.S..A authorities expect to make an overall saving of 3500 deaths per annum by constructing 40,000 miles of turnpike highways, we could expect to save at least half that number by adding 20,000 miles of controlled roadways to the roadways of this country ?

E. C. GORDON ENGLAND

Railway Conversion League,
London, E.C.1.
March 12, 1958.

SIR,—Allow me to applaud the appealing sense of the appropriate with which you juxtaposed, in your issue of March 14, a letter opposing " a complete transport dictatorship " and another implicitly inimical to the vested interests of " us all." May we be assured that Mr. J. E. Cule rejects absolutely the privilege of crossing on foot the Queen's highway, and never passes from pavement to pavement unless a footbridge, subway, or gated crossing is provided ?

I am, Sir, apprehensive of the ability of some citizens to accept and even acclaim institutions which do not pay dividends. Surely no commentator on the transport scene can escape suspicion of partiality unless he implacably and imperatively insists that road and air transport cease to pay a duty on fuel oil that is not levied from the railways ?

W. S. GRIEVESON

Darlington,
March 14, 1958.

Book Reviews

Aluminium in Building. By E. I. BRIMELOW, M.Eng., A.I.M., A.I.Mech.E. Macdonald and Co. (Publishers), Ltd., 16 Maddox Street, London, W.1. Price 42s.

A COMPREHENSIVE and detailed treatise on the application of aluminium to building construction is given in this book. After introductory chapters which contain generalities on the significance and history of this relatively new material, as these matters relate to building, the main topics are found under the following heads : architectural applications ; windows and patent glazing ; roof covering, wall cladding and insulated wall panels; structures; aluminium buildings; general applications ; practical aspects of fabrication ; and durability, protection and finish. Various appendices relate to matters such as notes on British Standards and guides to the selection of cast or wrought alloys.

It is only in the section on structures that the book begins to stray across that ill-defined border separating the province of building from that of engineering. Structural matters are confined to a dissertation on structural design and the special problems of design in aluminium such as buckling in beams and riveted, bolted and welded connections. One example is given—a brief description of the Dome of Discovery. In the next chapter on aluminium buildings, however, there is mention of two well-known aircraft hangars built in light alloy, which belong to the " structural engineering " rather than the " building " category. Although structural engineering is not the book's main concern, we feel that some mention, if only a brief one, should nevertheless have been made of noteworthy bridges in light alloy, such as the Arvida Bridge in Quebec, and the two bascule bridges in this country.

Books Received

Instrument Encyclopedia. Compiled by Edward W. Battey. The Herbert Publishing Company, Ltd., 27, Craven Street, London, W.C.2. Price 63s.

An Introduction to Press Tool Design. By J. Palmer. The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond Surrey. Price 3s.

Mécanique-Physique Générale. Sixth Edition. By M. Denis-Papin. Dunod, 92, Rue Bonaparte, Paris, (6e). Price 480f.

Digital Computer Components and Circuits. By R. K. Richards. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 64s.

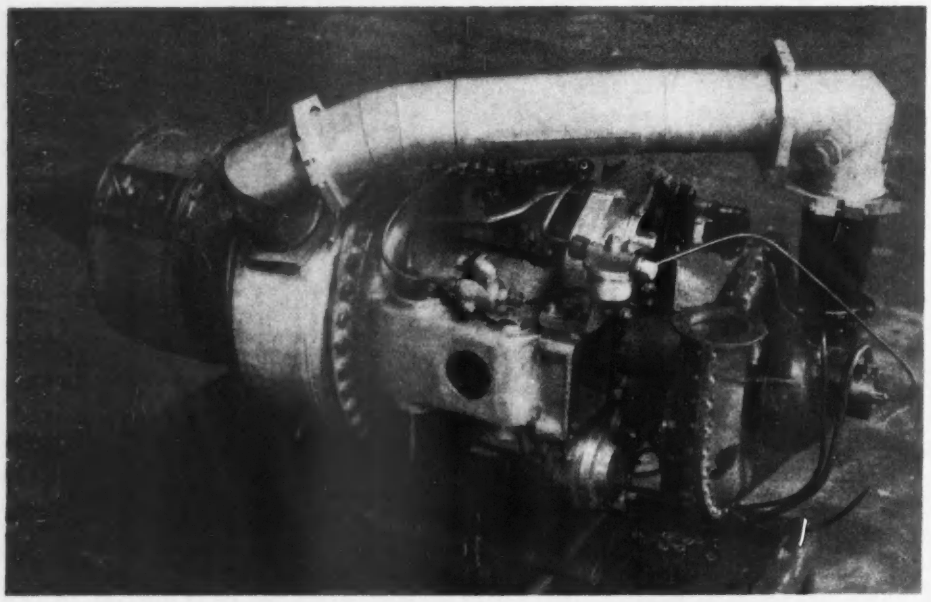
Steam Locomotive Design. Part I. By R. H. Mann. The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 6s.

Safe Loads and Properties for Square Tied Columns to CP. 114 (1957). Part One. By A. d'O. Smith. Published by the author at 17, Grosvenor Road, Richmond, Surrey. Price 3s. 9d. (obtainable by post only).

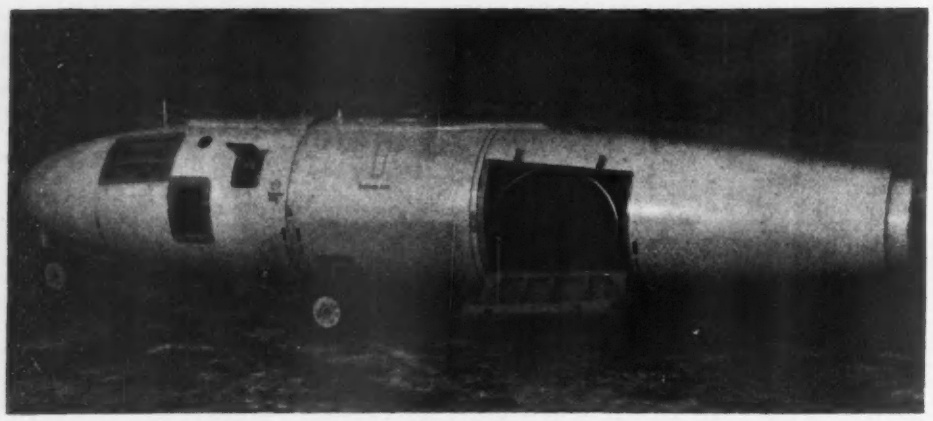
Small Gas Turbines

We have previously described and illustrated the Turbomeca gas turbines produced by Blackburn and General Aircraft, Ltd., under a licence agreement concluded in 1952. *They are now in service in various versions, including the "Palouste" air compressor supplying the rotor tip jets of the Fairey helicopter seen, right, landing on its Thames carrier at Brough. (Blackburn "Beverley" transports stand in the background.)*

OUR article of February 19, 1954 (pages 285–288) was illustrated with impressions of engines of the original Turbomeca series : since that date we have depicted the actual British engines, particularly the packaged "Artouste" on page 380, September 13, 1957, and its turbo-prop equivalent, the "Marcadau," on page 60, January 13, 1956. Of the engines originally intended for manufacture in this country, only the "Palas," "Palouste," "Artouste" and "Turmo" have actually been produced : the "Marboré," a larger jet engine, would have been required for any light jet trainer equivalent to the Temco "TT-1" of the United States Navy. No such aircraft being procured, the engine was not built here, and the "Marboré" for the single-engined Miles "Student" was a Turbomeca product. On a recent visit to Brough we were informed that there has been achieved a high level of commonality of components, the gas generators of, say, the "Palas" jet, "Artouste" fixed shaft turbine and "Turmo" free shaft turbine in the "600" series being interchangeable. (The "500" series have approximately two-thirds the mass flow.) Similarly, the second stage turbine is the same in the "Palouste" and the "Artouste," and a common reduction gear is used on "Artouste" and "Turmo." Such interchangeability, apparently, did not prevail in the original designs.



A high-pressure "Palouste" partly assembled : notice the worm drive clamps attaching the auxiliaries to the gear case



The low-pressure-air starting pod contains a "Palouste" aspiring through intakes on each side of the nose

Contrary to our report on page 61, January 13, 1956, the "Coupled Turmo" engine for helicopters has not been developed, the requirement for such an engine having lapsed; the Kaman "K-600-4" twin rotor helicopter has a pair of "Turmo" 600 engines driving into the helicopter gearbox—in emergency or for economical cruise one engine alone can be run. A further application envisaged for the "Turmo" is to the Saro "Skeeter," which at present has an unsupercharged piston engine. The overhaul life of the "Turmo" engine is now of the order of 1000 hours and it is hoped that 2000 hours will be attainable ; it will be recalled that the engine was originally conceived to drive an armoured fighting vehicle, and it has a conservative power-weight ratio, weighing about 310 lb for a maximum output of 450 s.h.p.

A particularly valuable use for small gas turbines is, of course, the starting of large gas turbines in aircraft, the use of a pneumatic starter motor dispensing with the supply difficulty of cartridges or liquid monopropellants and the need for heavy batteries or generators on the ground. The gas turbine which starts the first main engine may be utilised also as a generating plant and carried in the aircraft ; but either because this is not done or because the starting demand is excessive, ground-based air compressors for starting and air conditioning have been evolved. The "Palouste," with a pressure ratio of 3·88, provides up to 2·71 lb per second ("500" series) at the 45 lb per square inch pressure required by British engines. Illustrated on this page is the high-pressure "Palouste," with a delivery pressure ratio of 5·4 (optionally 8·0) for 2·3 lb per second for engines requiring

75 lb per square inch supplies. The higher pressure is developed by a second compressor handling bleed air only and located, as can be seen, on the end of the turbo-compressor shaft; a conversion kit is available for modifying existing engines. The second compressor is derived from a single stage centrifugal supercharger originally designed for use with a Blackburn piston engine; since this plant obviously has no provision for delivering shaft power, it is not anticipated that it will be installed aboard aircraft, and the double-volute casing is cast in iron instead of, say, magnesium.

Ground starting compressors using the "Palouste" 500 have been built in various forms, including a trolley which is regarded as unique in that it incorporates intake and exhaust silencing. Our description of the air starting "pod" shown at the S.B.A.C. exhibition last year was, we find, misleading in that we recorded that the wheels retracted into the streamline shell; in fact, only the undercarriage legs retract into the shell, the wheels being removed and stowed inside the pod.

Because of their light weight and compactness, it is considered that these engines have certain industrial uses—for instance, a stand-by unit for a high-efficiency base load generating engine might occupy only a very small area in a power station, while the cost of the engine, per horsepower, is not higher than for high-speed oil engines or gas turbines of heavier construction. Accordingly, an industrial alternator based on the "Turmo" has been evolved; the disadvantages of standard frequency machinery are eloquently exemplified by the total weight for a 250kW unit of 3 tons. (The 190 h.p. "Artouste" 400-cycle turbo-alternator abovementioned weighs about 400 lb.)

Further Development

The use of a single stage axial compressor upstream of the centrifugal impeller has allowed the parent firm to evolve the "Artouste" III of 700 h.p., and the "Turmo" III of 750 h.p. (in turbo-prop form, the "Bastan" of 650/750 h.p.). Blackburn and General Aircraft, however, have discovered the existence in this country of a two-stage transonic compressor with characteristics suiting it to compound the "600" series gas generator, and units including compressors to this design will be built in this country instead of versions of the new French engines. The three-stage compressor design is at present designated the "A.129," and will give 850/950 h.p.; to drive the 6·35 pressure ratio compressor will need two turbine stages, so the various units will have either two or three turbine stages. A free turbine engine, illustrated diagrammatically on this page, will be the first built, and is expected to run this year: it has a design fuel consumption of 0·77/0·66 lb per horsepower hour and will weigh 390 lb. (The present "Artouste" and "Turmo" have full load specific consumptions slightly better and worse, respectively, than 1 lb per horsepower hour.) It will be noticed that with this engine the Blackburn products will fall into line with the originals in using an annular air intake instead of a bifurcated duct.

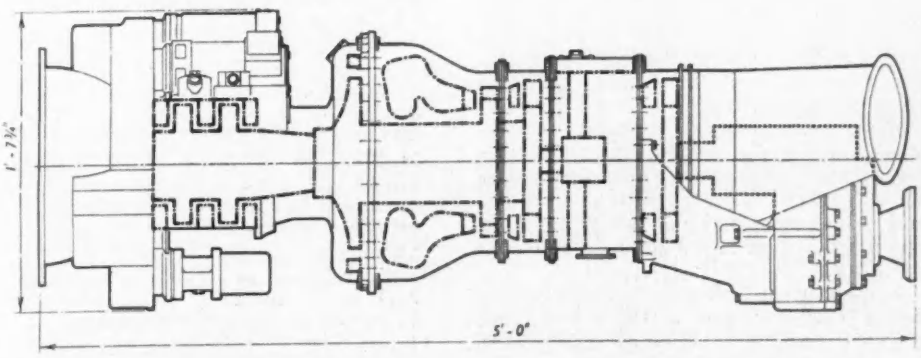


Fig. 3—The free turbine version of the "A.129" can be regarded as composed of a new low-pressure compressor casing added to a "Palas 600" compressor, turbine and combustor with the second turbine stage of a "Palouste"; beyond the gas generator is mounted a "Turmo" turbine and reduction gear

Future Development of Nuclear Power

In his James Forrest lecture to the Institution of Civil Engineers on March 18, Sir John Cockcroft discussed the further development of the United Kingdom nuclear power programme. He pointed out that the 1955 White Paper envisaged a total of 1500MW to 2000MW from nuclear power stations by 1965, based on a conservative forecast that these stations would have individual capacities of 100MW to 200MW, compared with the 70MW of Calder Hall. In fact, the design outputs of 275MW, 300MW and 500MW from Berkeley, Bradwell, Hunterston and Hinkley Point were greatly in excess of the forecast figures, and the overall programme had been increased to 5000MW to 6000MW to be installed by 1966. This advance was the result of straightforward engineering development: first, by an increase in the reactor size and in the amount of uranium fuel; and, secondly, by doubling the heat extraction per ton of fuel. Referring to experience at Calder Hall, Sir John said that in twenty-seven months of operation of the first charge of No. 1 reactor only three fuel elements out of 10,000 had developed slight sheath faults. Sir John's remarks on future reactor developments are given below.

THE 1955 White Paper suggested that the second stage of the U.K. nuclear power programme might use liquid cooled reactors, and in my 1955 lecture I briefly discussed three possible reactors—the pressurised and boiling water reactors and the liquid sodium cooled graphite moderated reactor.

During the last three years we have carried out a detailed design study on the sodium graphite reactor and a research study on the pressurised water reactor.

The liquid sodium cooled graphite moderated reactor has the potential attraction of attaining high outlet coolant temperature—of the order of 500 deg. Cent.—with correspondingly high thermodynamic efficiencies of the order of 37 per cent. The system pressure is low because of the low vapour pressure of liquid sodium, whilst heat ratings of at least 10MW per ton seem achievable with a cluster of small diameter uranium rods or uranium oxide fuel elements. So with these parameters reactors giving at least 400MW of electrical power would be possible.

To set off against these advantages, the neutron economy of the reactor is poor partly because of the absorption of neutrons by the sodium, and enriched uranium fuel of about twice the natural U235 content would be required. So fuel would be expensive.

More important still are the compatibility and safety problems of the reactor. Liquid sodium is not compatible with graphite, so they would have to be kept apart by pressure tubes surrounding the fuel elements. It would be necessary to use zirconium or an alloy of zirconium for the pressure tubes, since steel absorbs too many neutrons. Liquid sodium can be extremely corrosive if the oxygen content rises above a few parts per million, and at the present stage of development the inflowing liquid sodium in contact with the zirconium tube wall could not exceed 350 deg. Cent. For the main coolant circuit a low alloy steel compatible with liquid sodium would have to be found. Stainless steel would be too expensive.

Finally, we have the safety and maintenance problems associated with liquid sodium. The radioactivity of the sodium would amount to about 100 million curies, and although it decays with a half-life of fifteen hours, any leak would present lengthy and troublesome maintenance problems.

The possible economic advantages of the sodium graphite reactor do not therefore seem to outweigh its serious development and maintenance problems.

The pressurised water and boiling water reactors are the mainstay of the U.S. and Russian nuclear power programmes at present so they cannot be lightly dismissed. They are characterised by a small reactor pressure vessel—10ft diameter compared with the 50ft diameter of Berkeley and the 70ft diameter sphere of Bradwell. The heat rating of the fuel is high—about 20MW (thermal) per ton, so they start with an inherent scale advantage. The Yankee Atomic Power Company 140MW power plant is to cost £130 per kilowatt—about as high as the first C.E.A. power stations—but with development capital costs ought to be able to come down to the region of £90 per kilowatt.

The water moderated reactors have the disadvantage that enriched uranuim fuel must be used. The Yankee Atomic Power Company reactor will use uranium oxide fuel containing 2·6 per cent of U235. At U.S. prices of enriched fuel this would have a prime fuel cost of about £100,000 per ton with substantial additions for fabrication. The U.K. price for natural uranium fuel element is less than £20,000 per ton. Even if the expected long burn ups of 8000MW

days per ton are achieved, fuel costs at U.S. prices would be over 0·2 pence per unit.

Enriched uranium fuel produced in any European country would be much more expensive than in the U.S. This is because of the enormous scale of the U.S. diffusion plants—each of them uses 2000MW of electricity. Secondly, their electricity is extremely cheap—about 4 mils—about a third the price of electricity to a European diffusion plant. The U.S. diffusion plant can be thought of as bottling cheap Kentucky coal. Fuel costs in this country for PWR reactors would be about 0·35 pence per to unit.

The overall result is that even with maximum potential development, overall electricity costs in this country for PWR reactors would be unlikely to fall below 0·7 pence per unit. We are not therefore pursuing this reactor for large scale power. In the United States their prospects are more favourable because of the lower indigenous costs for enriched uranium.

We are therefore investigating two future lines of development. First, the development of the gas cooled graphite moderated reactor to the maximum of its considerable potentialities. Second the possible advantages of a change to heavy water as a moderator.

We have called the first of these projects the advanced gas cooled reactor (A.G.R.). The objective of the A.G.R. is to decrease capital costs per kilowatt by a substantial amount—of the order of 30 per cent—by increasing the surface temperature of fuel elements to about 600 deg. Cent. By this means and by using clusters of smaller diameter fuel elements, average ratings should be increased to the region of 8MW thermal per ton. To enable this increase of fuel element temperature to be obtained we will change from uranium metal fuel to a sintered uranium oxide fuel element. Sintered UO_2 has a melting point of about 2400 deg. Cent. This type of fuel is already being used in the Westinghouse PWR reactor and has been shown to have very good irradiation stability and burn-ups of up to 8000MW days per ton have been achieved.

The UO_2 fuel elements would probably be sheathed in beryllium. We have already fabricated beryllium cans and sealed them and have thermal cycled specimen fuel elements hundreds of times through the α B change point without damage. A first specimen is now going into our DIDO reactor to determine their overall irradiation stability.

We are already carrying out experiments with a zero energy reactor, NERO, to study the nuclear properties of the A.G.R. reactor.

Something would have to be paid for the high ratings and the use of uranium oxide, and the proportion of U235 will have to be increased slightly. To set off against the higher fuel element costs, the greater irradiation stability and higher efficiency ought to allow us to obtain about twice the amount of heat per ton. We believe, therefore, that overall fuel costs will be about the same as the first generation reactors—about 0·16 pence per unit.

Because of the high ratings, however, capital costs of the order of £80 per kilowatt ought to be achieved so that with the load factors of the order of 70 per cent predicted for the late 1960s overall costs should come down towards the 0·47 pence per unit prophesied by Sir Christopher Hinton for 1970 in his Axel-Johnson lecture. This at least is our target.

A promising alternative reactor to the A.G.R. is the heavy water moderated gas cooled reactor.

This reactor has the potential advantage of a smaller reactor size than the graphite moderated reactor leading to lower capital costs and it ought to be possible to achieve £80 per kilowatt in large outputs (500MW). Fuel ratings would be similar to those of the advanced gas cooled reactor, whilst because of the favourable neutron economy of heavy water reactors, only a slight enrichment would be required and fuel costs would be lower than for the A.G.R.

The use of a liquid moderator avoids stored energy and oxidation problems, and the fact that the moderator is kept cool reduces reactivity temperature coefficient problems.

Substantial quantities of heavy water would be required, and this would contribute between £10 and £15 per kilowatt to the capital cost of £80 per kilowatt. Heavy water is available at present in the U.S. at about £20,000 per ton. Technological work on heavy water production has been carried out at Harwell during the last few years and we believe that it would be possible to produce heavy water at comparable prices in U.K. and other European countries. The overall economics of the heavy water gas cooled reactor should therefore be as favourable as the A.G.R.

The ultimate development of the gas cooled reactor would substitute all-ceramic fuel elements for the designs using metal sheaths. This might allow outlet gas temperatures to be increased to about 700 deg. Cent., resulting in further increases of ratings.

The Authority is at present pursuing a research study on the high temperature gas cooled reactor. They are attempting to develop impervious ceramic sheaths for a fuel element which is a ceramic—a mixture of graphite, uranium and thorium. A zero energy experiment is being built at Winfrith Heath. This will enable the nuclear properties of the reactor at high temperature to be studied.

If successful this reactor might have applications to propulsion.

At the far end of the spectrum of reactor development is the Fast Reactor which has the objective of increasing the utilisation of uranium a hundred fold over the thermal reactors.

When the Fast Reactor project was started the outlook for uranium supplies to support a large nuclear power programme was far from assured. To-day, we have reached the point when uranium available to the West is over 30,000 tons a year and much more could be produced if necessary. This is more than is necessary to support any forseeable nuclear power programme up to the late 1970s, so the original urgency for developing the fast reactor has largely disappeared. However, in order to get reasonably cheap electricity from thermal reactor stations it is essential to be able to burn the by-product plutonium. This could be re-cycled in thermal stations or fed to fast reactors. The fast reactor may turn out to be the most economical method of doing this. This question will be resolved by the coming into commission of the Dounreay 60MW (thermal) fast reactor.

In the course of its design we have come to appreciate more fully the difficult technological and safety problems of this reactor so we will proceed cautiously with its operation and development and will not expect it to play a major part in our programme before the 1970s.

In the long run fusion reactors may replace fission reactors ; and certainly our final objective should be to use the energy available from fusion reactions in deuterium. This after all has been a very satisfactory energy source for the sun and stars for thousands of millions of years and if we can emulate their performance on earth we shall not only have an inexhaustible supply of very cheap fuel but we should have the satisfaction of solving one of the most fascinating scientific problems of our time.

Towards this, ZETA is only the first step in the way, though a most encouraging one. Encouraging because its initial performance shows that it has a considerable development potential, and we can begin to design for 100 million degrees when the energy output from fusion reactions would approach the energy input. Four years ago this would have been unbelievable.

Sir Leonard Owen, who is a member of your Council and who is managing director of the Industrial Group of the Atomic Energy Authority, has often expressed surprise to me that the members of your Institution do not take a wider interest in the application of nuclear energy to civilian use. Your charter, which defines civil engineering as "The art of directing the great sources of power in nature for the use and convenience of man; as the means of production and of traffic in states both for external and internal trade" would indicate that the civil engineer should take the widest possible interest in these nuclear stations. Up to now, he has contented himself with the problems of taking the heavy loads of reactors and shields on reinforced concrete foundations together with the details, such as cooling water, drainage, roads, &c. As any particular type of reactor passes out of the research stage into the project stage, an engineer must take charge of it who is responsible for all aspects. Up to the present, this engineer and his immediate assistants, with few exceptions, have come from the mechanical field, and the civil engineering part of the project is under their overall control. There would appear to be no basic reason for this, provided the civil engineer prepares himself to take the wider responsibilities

It has often occurred to me that to take control of the design and building of these modern and complicated plants, involving a wide knowledge of science and technology, a type of engineer should be trained who has a thorough grasp of the basic principles common to all engineering and is not just narrowly trained in the techniques of any of the current specialities such as civil, mechanical, electrical, chemical, engineering. One of the greatest problems in the rapid build-up of atomic energy has been the shortage of engineers who can take charge of the design and building of a complete project and who can, with their scientific colleagues, speed the development of really cheap power from nuclear energy. I am sure this will apply to other fields of engineering in the future.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

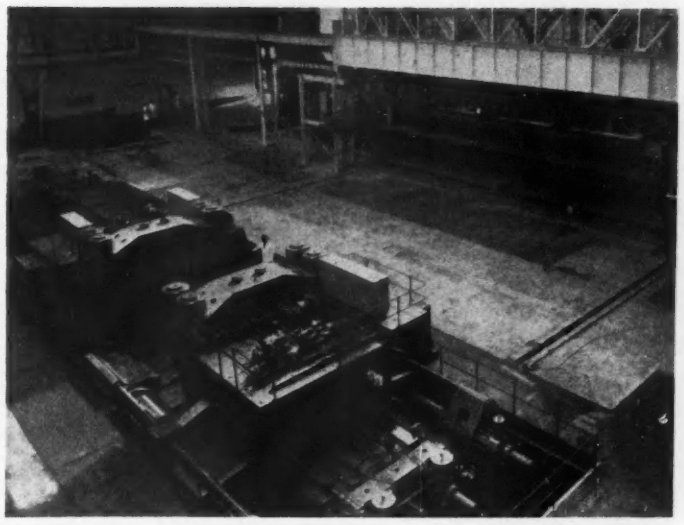
CHROMIUM NICKEL AUSTENITIC STEEL ELECTRODES FOR MANUAL ARC-WELDING

No. 2926 : 1957. Price 4s. 6d. In this new standard the method of identifying the electrodes is based on eight code letters, each of which relates to a specified chemical composition of the deposited weld metal. The suffix "—L" or "—R" is used in conjunction with the code letters, according to whether an electrode is suitable for d.c. or a.c. and d.c. welding. The marking clause requires each bundle or package of electrodes to be clearly marked with eight separate items of information—the "code marking" and a certification of the electrodes' conformity to the standard being among them.

Size of electrode, packing and storage, and initial and production control tests are dealt with.

A section on test requirements contains detailed test methods in respect of chemical composition and mechanical properties.

Production of Large Plates at Rogerstone



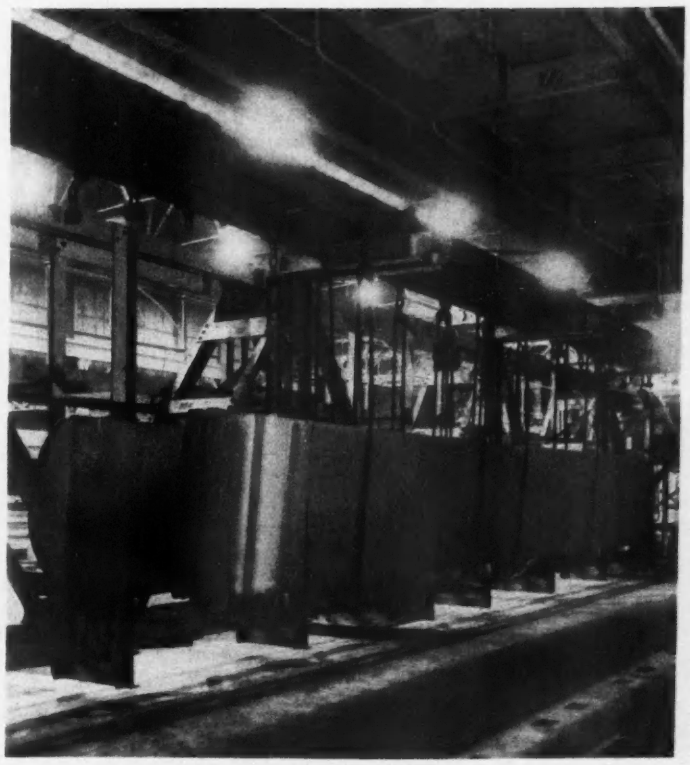
Some interesting new equipment placed in service at the Rogerstone works of the Northern Aluminium Company, Ltd., forms part of an expansion scheme by which large high-quality aluminium and medium strength alloy plates are to be produced in quantity for the aircraft, shipbuilding and other industries. Initially the new equipment is for plates up to some 50ft long, 10ft wide and 6in thick. It includes the stretching machine and bottom charging furnace illustrated on the right, a plate saw, a plate welding machine, and ultrasonic testing equipment.

DURING the next four years the Northern Aluminium Company, Ltd., proposes to spend some £10,000,000 on an expansion scheme which will not only increase output and production efficiency but also make available wider and longer plates in aluminium and the medium strength alloys to meet the needs of the shipbuilding, aircraft, chemical and other industries. Of the sum to be spent, £8,000,000 will be used for new plant and buildings and in the expansion of the rolling mill at Rogerstone, Monmouthshire, to increase the annual capacity from 75,000 tons to 175,000 tons. The continuous mill at the Rogerstone works was described in THE ENGINEER of September 29 and October 6, 1950. The principal additions to the plant will include a heavy duty 12ft wide hot mill for "breaking-down" ingots and rolling large plate ; the addition of a third stand to the present two-stand hot-finishing mill, with provision for a fourth ; and the introduction of hot coiling under tension direct from this mill. Preheating, annealing and re-melting furnaces will be among the ancillary equipment installed to serve the new hot line, and cold-rolling facilities will also be augmented.

An important stage in this overall expansion scheme was completed at Rogerstone recently when new plant to the value of £500,000 was placed in service. This plant includes a 4000-ton stretching machine for stress relieving and flattening heavy plates, a plate heat-treatment furnace, a high-speed plate saw, and an ultrasonic testing equipment. These new facilities for producing high-quality aluminium plate are primarily designed to meet the aircraft industry's demand for thick, high-strength aluminium alloy plate for machining into integrally-stiffened wing skins and similar aircraft parts ; and the shipbuilding industry's call for aluminium plate in the medium strength alloys, in sizes wider than have hitherto been available.

The heat-treatment furnace to be used in the production of plates for aircraft construction is of bottom-loading design and incorporates means of quenching. It is intended for both of the stages of heat-treatment that high-strength aluminium alloys undergo before their full properties are developed. These stages are solution treatment, in which the metal is heated to a fairly high temperature and then quenched, and precipitation treatment or artificial ageing in which the plate is heated to a lower temperature and allowed to cool slowly. The furnace, which can also be used for annealing when necessary, was designed and built by Stordy Engineering, Ltd., and can be seen in the photographs reproduced here.

The furnace itself is carried on an overhead structure and has the quench tank situated immediately below. Its capacity is nearly 20 tons of plate for ageing at temperatures up to 200 deg. Cent. without quenching ; 10 tons for solution-heat-treatment up to 550 deg. Cent., with a slow quench ; and 5 tons for solution-treatment up to 550 deg. Cent., with a high-speed quench. Like the rest of the new equipment it is designed to handle plate up to 55ft long, 10ft wide and 6in thick. The furnace is electrically heated with the heater batteries and air circulation fans mounted at each end, outside the furnace chamber. The total heater rating is 1494kW, each heater battery having three sections

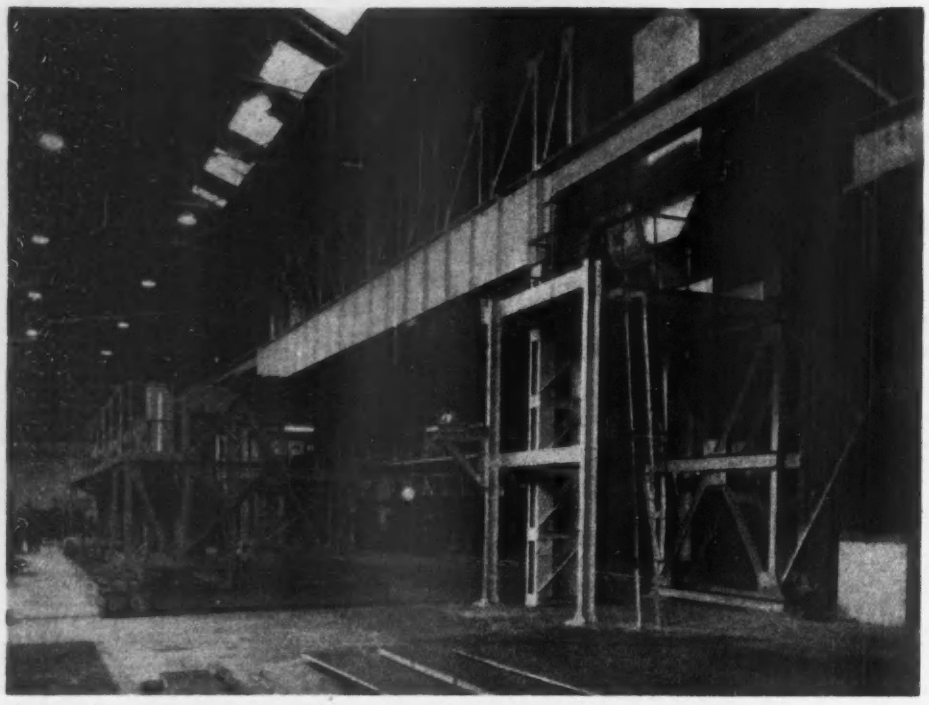


Heat treatment furnace with a load of plate suspended from a charger being moved into position

(166kW, 249kW and 332kW) with independent switching to allow fine temperature control. Two fans at each end of the furnace are used for circulating air, which is drawn through stainless steel ducting from the top of the furnace chamber, passing through the fans, then through the heaters, from which it is again ducted to the furnace chamber. Each fan is driven through vee-belting by a 40 h.p. motor. The furnace is of stainless-steel-lined construction and is entirely without refractories. The whole furnace structure is carried in a riveted and bolted steel box girder which is supported at each corner by a massive compound stanchion. Asbestos-sealed sliding joints incorporated in the furnace casing allow for expansion.

The door at the bottom of the furnace is insulated in the same way as the furnace itself and similarly lined with stainless steel. It is made of a number of 6ft square sections joined to make one continuous door, and when closed its sealing is maintained by asbestos cord, carried in heat-resisting castings round the edge. When the door is closed, this cord is pressed against corresponding castings around the opening in the bottom of the furnace. The operation of opening or closing the door involves two distinct actions, a moving into position and a sealing or unsealing action. To make these two movements possible the door is mounted on toggles which are operated through linkages by two hydraulic cylinders. These toggles serve to raise or lower the door through a few inches when sealing or unsealing. The whole door and its sealing mechanism are in turn mounted on a carriage, which spans between rails set 60ft apart, and when it is required to close or open the door this entire carriage is driven about 8ft along the rails. When the door is in the closed position, brackets are engaged so that the forces exerted by the sealing operation are carried by the main furnace steelwork and are not transmitted to the door carriage.

The furnace load is carried on seven full-length joists, with one piece of plate supported



Bottom-loading furnace with charger run out on shop floor for loading

by each joist. These joists rest on four short transverse bearers which are attached at their ends to hoist chains passing through the roof of the furnace and over pulleys to drums mounted on a shaft at the rear of the furnace. Drive to this shaft, for raising and lowering the load, is provided by a 45 h.p. d.c. motor, powered by a motor generator set with Ward-Leonard control. The control gear is so set that all loads are raised into the furnace at a speed of 20ft per minute, while lowering can be carried out at 20ft per minute or at quenching speeds of 90ft or 180ft per minute. Safeguards are provided so that loads weighing over 10 tons can be lowered only at 20ft per minute, and no load weighing over 5 tons can be lowered at the fast quench speed.

A furnace charger, running on rails at each end of the furnace and spanning the quenching tank, is used for loading. The rails extend well out on the shop floor so that the load can be placed on the charger by an overhead crane and then traversed under the furnace, where the load is transferred to the hoist chains.

The quenching tank, sunk into the floor immediately below the furnace, is 102ft long, 10½ft wide and 15ft deep. Much of this length and width are occupied by circulating pumps and passages, and the useful size of the tank for quenching purposes is 60ft long, 6ft wide and 15ft deep. The two Allen axial flow pumps, which have provision for alteration of impeller blade pitch, are used for circulating the water during the quenching operation.

Plate Stretcher and Plate Saw

The plate stretching machine, which is to be seen in the adjacent illustration, was designed and built to the special requirements of the Northern Aluminium Company, Ltd., by the Loewy Engineering Company, Ltd., It has a rated pull of 4000 tons and is capable of applying a controlled stretch to light alloy plates up to 50ft long, 10ft wide and 6in thick, and with a maximum cross-sectional area of 200 square inches.

The stretcher consists of two main compression members, one each side of the machine; and in side-elevation these members are level with the centre-line of stretch. Mounted directly on the ends of the compression members are two main hydraulic cylinders, with rams bearing on side extensions of the main grip-head. This head is carried on horizontal bearing surfaces, and moves during the action of stretching.

The tail grip-head is fixed relative to the compression members during stretching and its position is adjustable along the compression members so that pieces of plate of various sizes can be accommodated. For tail grip-head adjustment, nine anchor holes are provided in the compression members at 4ft 6in pitch, and in these holes the head is locked according to the length of the plate being handled. Adjustment of the position of the head is made in a series of 4ft 6in steps, by ram-operated tow-bars sliding inside the compression members. In this operation pins fitted in the head engage with the tow-bar for the movement of the head, and then disengage to allow the tow-bar to return for the next step. When the head is in the required position, overstroke rams facilitate the engagement of the anchor pins in the holes in the compression members. The two main stretcher rams are of 36½in diameter, and have a 7ft 6in stroke. The main cylinders are not used to effect a fast advance and return of the main head when not stretching and the head is moved by double-acting 8in diameter rams acting on the main head. The cylinders in which these advance-and-return rams operate are attached by long tie-bolts to the main cylinders.

The main compression members are held in alignment with each other, and with the foundation, by self-centring rams arranged at the tow-bar end. Tie rods connect the centring rams to the compression members and to the foundation. To prevent any possibility of accident from the open anchor pin holes each compression column is covered throughout its length by a wooden slat apron, which passes around guides and rollers over the anchor pin gear. A continuous disappearing apron attached to the adjustable head fills in the space between the heads and also acts as a support for a plate prior to stretching. Once a plate is placed on the apron its manipulation into the grip heads is effected mechanically, devices being provided on each head for raising the plate ends to facilitate entry into the jaws, and also for plate centring. Lengthwise positioning is by means of plate locating stops within the jaws.

The grip jaws of both heads are in ten segments, each top and bottom pair of which is mechanically centred, and all the segments are able to move to a small amount relative to each other to accommodate a degree of variation in the thickness of a plate. To give the heavy initial "bite" necessary to hold the plate the jaws are moved by 400-ton hydraulic rams. The depth of penetration of the plate in the head, and hence the length of grip, is determined by a plate locating device, which has two preset positions which are selected according to the width and thickness of plate. In addition to jaw segment movement, the main head is capable of a limited angular movement to allow it to take

4000-ton plate stretcher for stress-relieving the large pieces of high strength aluminium alloy plate. It is capable of handling material up to 50ft long, 10ft wide and 6in thick

plate that might be slightly wavy along one edge.

A general requirement of the hydraulic system of the machine is the necessity for control of two rams widely spaced apart, but required to travel at the same speed. This occurs with the main advance-and-return, tow-bar and jaw operating rams. Control is effected by driving the two rams by separate pumps, and controlling the flow from each pump by bleed-off valves operated by a differential mechanical linkage. In this manner cross-wise alignment of the heads is maintained. In the case of the main head, a limited amount of free angular movement is allowed (at the beginning of an actual stretching stroke only) before the balance gear comes into play. The machine has three separate oil hydraulic systems, one on each grip-head, and a main one in the foundation supplying the main cylinders, the advance-and-return cylinders, and the tow-bar rams. The main system is charged by two pumps driven by a 150h.p. double-ended motor. These pumps deliver oil at 4500 lb per square inch, but there is provision for increasing the pressure to 7000 lb per square inch to enable the stretcher to exert a 6000-ton pull.

The hydraulic systems in the grip-heads supply the jaws and the plate lifting, centring and locating devices ; whilst on the adjustable head they also supply power for the manipulation of the anchor and tow-bar pins. Two pumps are mounted on each head ; one driven by an 18 h.p. motor supplies oil at 4500 lb per square inch for the jaw-operating cylinders, the tow-bar and anchor pins on the adjustable head, and pilot pressure at 300 lb per square inch for the control valves. The second pump, driven by a 4 h.p. motor, delivers oil at 4500 lb per square inch to the operating cylinders of the plate lifting, centring and locating devices.

All controls necessary for the operation of the stretcher are mounted on control desks, carried on each head. A stretch indicator on the main head control desk shows the length of plate between the jaws and the amount of elongation applied. The degree of stretch can be preset at 1, 1½, 2, 2½, 3, 4 or 5 per cent and operation automatically stops as soon as the preset value is reached. An alternative provision is made for stretching to a predetermined stress.

The machine is protected from shock damage should a plate break while being stretched. When a plate breaks, the grip-heads are accelerated outwards, and the two broken parts of the plate are projected into the heads. Large pressure relief valves are fitted to protect the tow-bar cylinders, the main head advance cylinders and the jaw cylinders, and stop the outward movement of the heads. During this outward movement the foundation is protected from shock by compression member centring cylinders incorporating relief valves. Movement of the whole stretcher structure relative to the foundation is thus possible. Residual shock loads remaining after hydraulic damping are finally transmitted to a prestressed concrete beam built into the foundation. The attachment of the stretcher to this beam by means of two tie rods is the only longitudinal fixing for the entire machine. After displacement caused by plate breakage, all parts can be returned hydraulically to the normal position relative to the foundation.

The saw supplied by Wadkin, Ltd., for cutting plates up to 55ft long, 10ft wide and 6in thick is designed to reduce need for plate handling to a minimum whilst providing means of keeping the material squarely, accurately and firmly located during machining. As may be seen in the accompanying illustration, the machine is surmounted by a single box-section beam which spans the full length. This 20-ton beam is 68ft long between its pin supports and 6ft deep at the centre of its span. Within the beam there are carried eighteen pairs of hydraulic jacks, which hold the plate to the table. A circular saw which travels the length of the machine beneath the beam, has its blade located beneath the centre of the beam's cross-section and projects upwards between plate conveyor tables.

The saw is driven by a 75 h.p. motor housed in a 14ft long saddle. This saddle, which also carries a 6¼ h.p. feed motor, rides on two flat longitudinal bearing surfaces, and passes through the arches of the beam supports at each end of its travel. The base of the whole machine is 5ft 5in below floor level with the saddle bearing surface situated 2ft 1in above the base. For moving plates into position beneath the beam seven infeed and seven outfeed conveyors project at right angles to the beam and on each side of it. Each of these conveyors is 2ft wide, by 12ft long, and is driven by a 1½ h.p. motor. The surface height of the conveyors (and hence the working height of a plate when being sawn) is 2ft 6in above floor level. The hydraulic jacks used to hold the plate in position and the conveyors are not spaced evenly along the length of the machine, but are grouped more closely at the control panel end so that short lengths of plate can be accommodated without difficulty. These plate conveyors were built by the Albert Mann Engineering Company, Ltd. To provide an accurate square cut when end-sawing, a straight-edge is fitted along the length of the first pair of conveyors, at right-angles to the line of saw cut.

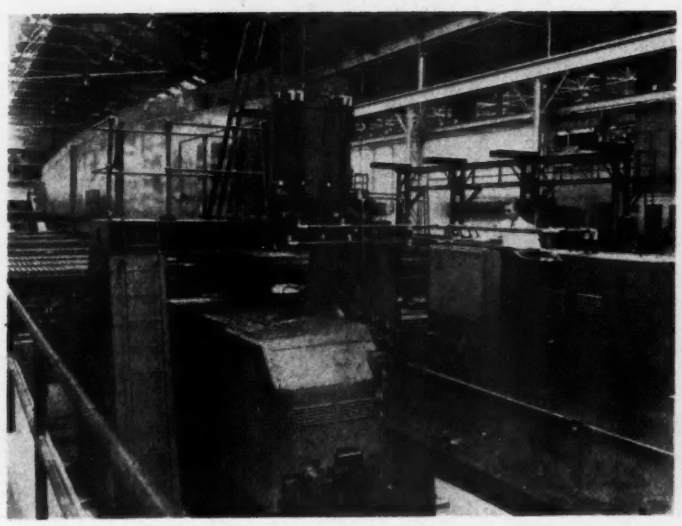
The controls of the machine incorporate safeguards, in the form of interlocked switches, to prevent the possibility of operations being carried out in the wrong sequence. For example, the saw feed motor will not operate until the plate is clamped and the saw spindle running, and the conveyors cannot be started until the plate clamps have been released. Although plate up to 55ft long can be sawn with the machine in its present form, provision has been made for ultimate extension to cut plates up to 75ft long. At the control end the bed of the machine is extended so that the saddle can run out clear of the beam support, as shown in one of the illustrations. Swarf is carried away by a drag-link conveyor beneath the saw.

Considerable development work has gone into the design of the saw blade itself, which is required to cut aluminium alloys with a wide range of hardness. A saw with a tooth pitch of about 4in, with a very deep gullet, has been found satisfactory for cutting most of the usual plate alloys. The saw teeth are tipped with tungsten carbide, and very high feeds and speeds can be employed. For example, plate in " Noral 2S " (commercially-pure aluminium) and " Noral 26S " (a high-strength aircraft alloy containing copper), 6in thick, has been sawn at a feed speed of 90in per minute, with a saw peripheral speed of 10,000ft per minute. Thinner plates can be cut at greater feed speeds, and material of 3in and below can be readily cut at 180in per minute.

Plate Welding and Ultrasonic Testing Equipment

The new welding equipment installed enables the company to offer aluminium plate up to 11ft wide by about 30ft long, whereas limitations of rolling mills have hitherto restricted aluminium plate made in this country to a width of about 7ft.

This wide aluminium plate, which is available in the non-heat-treatable alloys such as " Noral 2S," " B54S " and " M57S " in thicknesses up to 0·4in, is made by butt-welding two plates together, in a process that allows the final plate to be regarded, for



High-speed plate saw with saddle retracted to one end of machine (left). This saddle traverses beneath the 68ft beam, which carries hydraulic jacks for holding the plate. The saw can be seen in operation in the right-hand illustration

virtually all welded work, as normal rolled plate.

The equipment consists essentially of a 35ft long concrete base carrying a welding jig. The two pieces of plate to be welded are placed flat, edge-to-edge, with an appropriate welding gap on the jig, which holds them firmly in place. The overhanging part of one piece of plate is supported on trestles, the other by a plate turn-over table.

Welding is carried out by an "Argonaut" welding head operating fully automatically on a self-propelled carriage, and at speeds generally between 15in and 150in per minute.

After completion of the weld, which is made in one pass, the top weld bead is removed and the plate lifted off the welding rig by an overhead crane. The plate turn-over mechanism then reverses the plate for removal of the under-bead.

The ultrasonic testing equipment installed was designed and built by the Curtiss-Wright Corporation and enables plate to be inspected in fully-immersed conditions. It ensures complete examination of an entire plate, except for a thin "dead" zone comprising the top 0·10in skin of the material under test. The steel tank of water used for testing is 14ft wide, 3ft deep and 54ft long and is built up in 4ft sections. The probe unit is mounted on a carriage which in turn is carried on an aluminium scanner bridge of lattice construction, running on rails at each side of the tank. In this way the whole plan of the tank can be covered by the probe, which can be raised and lowered according to the thickness of the plate under examination. Bridge and carriage motions can be automatically or manually operated by switches, and their speeds are infinitely variable from 5ft per minute to 90ft per minute. The controls can be set so that repeated automatic sweeps by the probe unit across the plate can be made by moving either the bridge or the carriage in steps of from $\frac{1}{2}$in to 12in.

Of the two "scans," the first ("A") supplies two-dimensional "pip" echo information at the first oscilloscope, telling the operator the depth in the metal at which a flaw has been found and its size. Size is indicated by the amplitude of the trace, while depth is shown by relating the position of the echo on the screen to those echoes received from the top and bottom plate surfaces. The second (B-scan) enables the operator to see a longitudinal or transverse section of the plate being inspected, the top and bottom surfaces being represented by bright horizontal traces on the screen and defects being indicated by bright spots. By correlating this information with that received at the A-scan, a complete picture of the flaw and its position is obtained. To ensure that no flaw is overlooked (by failure to notice the "pip" on the screen, for example), the controls can be set so that scanning is automatically stopped when an echo signal is detected.

Another recent addition at Rogerstone is a large office building in which all the works' departments—managerial, material and plant control and engineering design—have now been concentrated instead of being distributed in a number of separate buildings over the works area. This new building is in the form of a rectangular block about 250ft long and 45ft wide, four main storeys in height. The accommodation is arranged in three of the main floors, with a lower ground floor to the rear of the site in addition. Provision has been made for later expansion to add another 10,000 square feet of floor space.

Diesel Locomotive Crane with Hydraulic Transmission

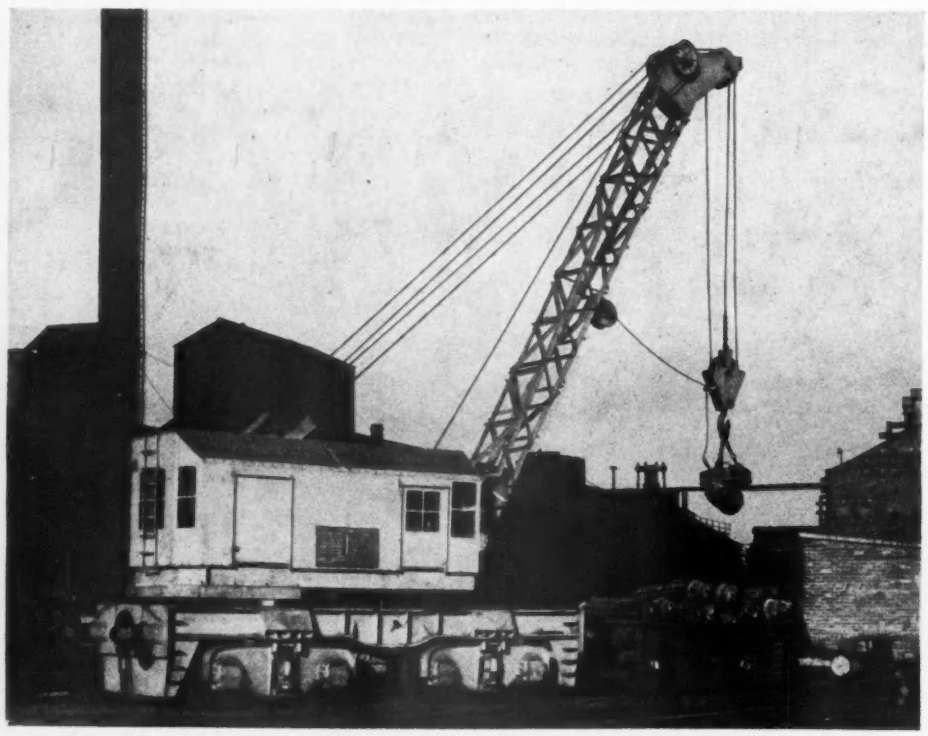
A diesel-locomotive crane of improved design, now being made by Joseph Booth and Brothers, incorporates hydraulic transmission to the hoisting, derricking and travelling motions, which are engaged through air-operated clutches. These cranes, on a twin-bogie carriage, have a 35ft jib, and a lifting capacity of 10 tons at 16ft radius and 15 tons when blocked. On a four-axle carriage they lift 10 tons at 18ft radius and 15 tons when blocked.

LOCOMOTIVE cranes have been made for many years by the Joseph Booth and Brothers branch of Clyde Crane and Booth, Ltd., Rodley, Leeds, and an interesting recent development of this company is a 10/15-ton diesel-engine-driven travelling crane incorporating the "L.E.H." hydraulic transmission system. The hydraulic transmission now fitted is stated to impart to the crane the full advantage of availability of an oil engine drive, coupled with the smooth motion speed control, simple reversing and flexibility which was a feature of steam-driven cranes. Ten of the cranes have been ordered by the Western Region of British Railways, and the first to be completed was handed over recently. The general arrangement of the machinery on the superstructure of the crane can be seen in the drawing we reproduce.

The machinery is carried on machined facings on the superstructure frame of rigid steel construction, and a roller path on the underside of the frame mates with the slewing rollers. The carriage on which there are mounted the slewing ring and roller path can be of four-axle twin-bogie or straight four-axle construction, with an overall length of 26ft 6in over the buffers. A 35ft jib fitted on a twin-bogie carriage gives a lifting capacity of 10 tons at 16ft radius or 15 tons with blocking jacks in position. On a typical four-axle carriage the crane has a lifting capacity of 10 tons at the 18ft radius, free duty, and 15 tons at 18ft radius blocked.

The 75 h.p. oil engine drives the eighteen-ram radial hydraulic pump of the transmission system directly through a flexible coupling, and is governed to run at a maximum speed of 1000 r.p.m. This pump supplies fluid to a sixteen-ram hydraulic motor coupled to the motion primary drive shaft and through a valve gear assembly interposed in the connecting piping there is made available a selection of motor speeds of 83, 166, 250 and 500 r.p.m. in either direction with the engine running at its full governed speed of 1000 r.p.m. Speed changes are effected by the operation of a valve which cuts off the supply of hydraulic fluid to a series of the ram cylinders in the pump or the motor. This has the effect of directing a variable volume of fluid through the remaining cylinders. Reverse drive is obtained by operating a valve which reverses the direction of fluid flow to the hydraulic motor. The closed hydraulic system is so designed that under maximum load conditions the fluid pressure does not exceed 2500 lb per square inch. A needle control valve which is used to admit fluid to the motor ensures that motion is taken up smoothly. When the engine is running with the crane standing the pump delivery is returned to exhaust and no load is imparted to the system. When the motor is being overrun during the lowering of a load it acts as a pump and load control is increased by throttling the fluid delivery through the valve gear.

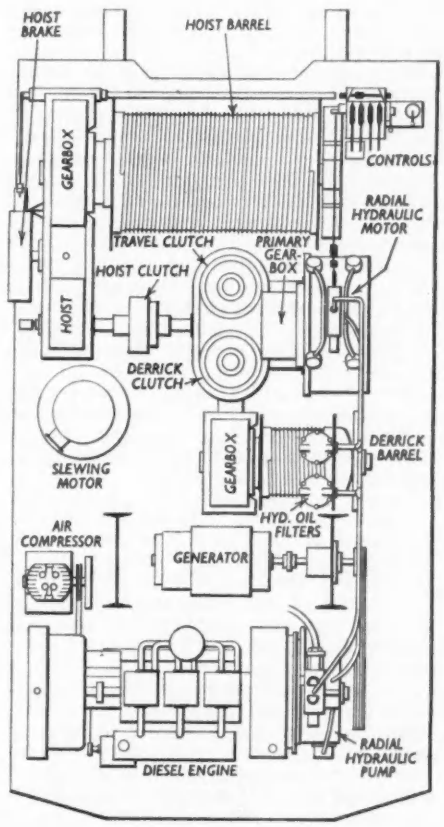
The main transmission gearbox is driven by the hydraulic motor through a splined coupling shaft and through an arrangement of clutches the hoisting, derricking or travel-



10/15-ton diesel locomotive crane with twin bogie carriage. This crane is powered by a 75 b.h.p. engine and has hydraulic transmission to its hoisting, derricking and travelling motions

ling motions can be engaged as desired. Air-operated friction clutches are used to engage each of these motions, and air for this purpose is supplied by a compressor driven by belt from the engine. The makers point out that slewing is always a problem on any crane with common prime mover as the power available is approximately six times the maximum required for this motion and often it is desired to slew at a slow speed whilst hoisting at maximum speed. For this reason it was decided to treat the slewing motion separately and this drive is provided by a reversing motor developing 7 h.p. at 1000 r.p.m., for which current is supplied by a generator driven through vee belts from the oil engine. This generator is wound to give full excitation at engine idling speed so that full power for slewing is always available.

The primary gearbox power take-off shaft extends into the main hoist gearbox which consists of a double spur reduction to the hoist barrel. The air-operated clutch is



Arrangement of machinery on locomotive crane

incorporated on this shaft extension. Although the use of hydraulic power transmission enables loads to be hoisted or lowered under power without the need to apply mechanical braking, a hoist brake is provided for use if necessary on the hoist motion intermediate shaft. The drives for the travelling and derricking motions are taken from a spiral gear on the primary shaft. The derricking drive is transmitted through an air-operated clutch, spiral bevel and worm gearing to the derrick barrel. An automatic Weston design brake is incorporated in the derrick drive worm gearbox and the thrust from the worm shaft provides the necessary load for applying this brake.

The travelling drive is taken down through a vertical shaft to a spiral gearbox mounted on the underside of the carriage and the drive from this gearbox to the axles is transmitted by Hardy Spicer cardan shafts, thus providing a true universal drive. The use of hydraulic transmission shows to particular advantage in the travelling of the crane. On the slow-speed ratio full torque is available for inching, whilst the normal full speed is available at full torque for shunting duties. A high speed on the fast ratio is used for moving the crane over long distances. Normally, cranes for industrial use are supplied on double four-wheel bogie carriages, but where headroom is limited in order to clear low loading gauges, other types of carriage can be supplied.

The main controls in the driver's cab include a drum controller for the electrically driven slewing motion, a hoist brake pedal, an engine throttle pedal, and a manifold with eight levers for the compressed-air-controlled motions. Three of these eight levers control the hoisting, derricking and travelling motion clutches and two the travel and slewing brakes. One of the remaining three levers, which are used to control the hydraulic motor speeds, is positioned to set the hydraulic system for the slow and fast ratios, and the other two the creep speed and full speed in each of these two ratios. Thus, with the first lever set for the slow ratio one of the two levers can be set to give the slow creep speed of 83 r.p.m. or the full speed of 250 r.p.m. With the first lever in fast ratio the selected levers give a slow creep speed of 166 r.p.m. or a fast speed of 500 r.p.m. On a typical crane these speed controls are arranged to give hoisting speeds from 36ft to 72ft per minute ; derricking speed of twenty-four seconds minimum to maximum radius, and travelling speeds from inching up to 4½ m.p.h. The engine is preset to run at an idling speed of 400 r.p.m. and at a maximum speed of 1000 r.p.m., as already stated.

Problem of Mining Subsidence

It is unusual to hear of damage caused by mining subsidence in the London area, but such damage has, in fact, occurred at Plumstead. Here, chalk was extracted from shallow workings which have been disused for fifty years. The London County Council has been responsible for a programme of filling in these old workings, which is of special interest. One of the buildings affected by the old mines is the London Transport garage at Plumstead, and the following description of the way in which the danger of subsidence is being overcome has been sent to us by London Transport.

The old chalk mine workings are 60ft to 80ft under the Plumstead garage ; they are unsafe in parts and there have been falls of chalk from the roof. From a new heading 200ft long, driven in the chalk, the lines of the old tunnels are being traced and underground falls are being marked down for filling. Pulverised fuel dust from power stations, suspended in water, is being washed into the workings. The dust sets into a pumice-like mass as the water drains away, providing firm support for the ground around it.

The chalk mines were abandoned early in the present century when the increasing efficiency of motor transport made it cheaper to bring in chalk from other areas than to work the mines. The chalk was needed for brick-making and lime-burning in the Woolwich area. The mine tunnels seem, as far as present explorations show, to have been driven in a grid pattern of main and side galleries. Sufficient chalk was left between the tunnels to support the ground above.

The method of mining adopted was to drive the tunnels close to the top of the chalk layer, with a roof 4ft to 5ft wide and sides sloping gradually outwards in an A-shaped cross section. As the chalk was dug away the tunnels were deepened until water level was reached. The height of the tunnels was about 20ft and the width at the bottom about 10ft when completed. The tunnels were not shored up in any way. The chalk was taken out by shafts, but access to the mine was probably by an adit, although it has not yet been found.

There were two main workings, one under the southern part of Plumstead garage and houses in Alliance Road, and the other further east. The first intimation that these workings existed under the garage was given in 1916, when a hole 15ft across and 30ft deep appeared in the floor. A lathe vanished into the hole and part of the garage wall and roof collapsed. There have been no signs of settlement since.

Early in 1938, there were subsidences in Alliance Road. The London County Council and the Woolwich Borough Council investigated them and discovered that some of the old chalk workings had fallen in and that workings under the western end of Alliance Road were in danger of collapse. As the tunnels were near the garage, the London Passenger Transport Board had four bore-holes sunk in the spare ground on the south-east side of the garage, and three bore-holes disclosed cavities. The outbreak of war, however, caused operations by the councils to be suspended.

Since the war the two councils have explored a good proportion of the workings and have now filled most of them. The L.C.C. is acting as agent for London Transport in dealing with workings below the garage itself, but is also carrying out similar work under residential property nearby. A 200ft heading has been driven from the end of an existing gallery running from an access shaft in Alliance Road. The heading runs diagonally across the garage to a point underneath the spare ground about halfway along the garage wall, and has penetrated a number of old galleries, some of which have already been filled for safety, while filling of others, in better condition, is being left until further exploration has been carried out.

One difficulty is that many passages are barred either by deliberate filling in the past or by falls of chalk. It is necessary in every case to establish whether these falls are the result of a drop in the ground extending right from the surface or whether they are falls of material from an intermediate level which have left voids in the sand and chalk above. Three such domed voids have been found so far and are being filled. To assist in the work, several shafts have been sunk, some inside the garage itself.

The method of filling adopted by the L.C.C. and the contractor, John Mowlem and Co., Ltd., is of great technical interest. The material used is the ash from power stations using pulverised fuel. This pulverised fuel dust is cheap and readily obtainable in London. A load of dust is tipped alongside one of the many 4in to 6in bore-holes which have been made during the investigation. It is then washed down the hole by jets of water and led underground to a sump or tank. From this, the slurry of water and flue dust is allowed to run by gravity, or is pumped, to the point where filling is proceeding.

The tunnel or dome to be filled is blocked off by improvised bulkheads. Sufficient flue dust slurry is then pumped in to form a layer, and is allowed to settle. The water in which the dust is suspended drains away and in a few hours the dust is consolidated sufficiently for a further layer to be formed on top. This process is continued until the space is completely filled, the slurry for the last layers being run in through pipes in a similar manner to the method used for cement grouting. Cavities in clay and sand are packed with shingle and compacted with dust slurry. It is expected that exploratory work under the garage will be completed in eight to ten weeks' time. Filling will then be a comparatively easy matter, we are informed.

London Transport Equipment.—The fourth prototype "Routemaster" has now commenced service trials in London, running on Route 8. Designated "RML3," it resembles the "CRL1" (page 611, October 25, 1957) in having Leyland running gear, but coil springs instead of torsion bars are used at the front. The body is built by Weymann's, Ltd., and the length has gone up to 27ft 6in. As on the A.E.C. vehicles in their original form, electro-hydraulic operation of the transmission is used (see page 415, September 24, 1954).

SHORTER REPORTS

Marine Engineers Annual Dinner

At the fifty-fifth annual dinner of the Institute of Marine Engineers, held on March 14, the toast of "The Royal and Merchant Navies of the British Commonwealth" was proposed by Sir Edwin McCarthy, the Deputy High Commissioner for Australia. Both services, he said, were bound up with the development of the Empire and Commonwealth and there was no question of any reduction in naval forces until prospects of conflict became remote. Sir Edwin touched on the difficulties of maintaining merchant fleets and the trends in international trade; he thought that there was too much protection of industry, with adverse effects upon shipping and the standard of living. He advocated greater freedom of trade and the liberalisation of trade, both inside and outside Europe, and was against too great a degree of self-sufficiency, since this meant reduced demands for transport. Mr. R. G. Grant, in his reply, said that shipowners welcomed the co-operation of the Royal Navy and pointed out that the merchant navy, on its part, stocked the larder, was responsible for a share of the national income and so provided money to subsidise the Royal Navy. Viscount Simon gave the toast of "The Institute of Marine Engineers" and briefly outlined the history of the engineer at sea, technical advances and their effect on the economic life of Great Britain and the Commonwealth. He warned against the dangers of complacency and pointed out that we could not always expect to be in front since other people were just as well equipped and could overtake. Although shipowners continued to give support to British shipbuilders, he made a plea for prices to be kept down and efficiency up to help the industry to face competition. He concluded by noting the efforts of the Institute to maintain standards and to spread knowledge and suggested that more foreign engineers should be encouraged to present papers. The president, Sir Ronald Garrett, in his response, reported upon his tour of the sections and read greetings from Australia, and went on to remark that the decentralisation policy was proving right and that the Institute continued to increase its membership.

Boiler Natural Circulation Investigations

On March 7, A. M. Laird, B.Sc., Professor A. W. Scott, B.Sc., Ph.D., and Professor A. S. T. Thomson, D.Sc., Ph.D., presented a paper, "Natural Circulation Investigations on an Experimental Two-Tube Boiler," to the North East Coast Institution of Engineers and Shipbuilders, which is summarised below. The paper describes the British Shipbuilding Research Association experimental two-tube water-tube boiler built to investigate natural-circulation phenomena and designed for 1500 lb per square inch maximum pressure and a maximum heat-input rate of 120,000 B.Th.U. per hour per square foot. Details of instrumentation are given and it is noted that provision was made for varying tube diameter, length and inclination. Experimental results, all relating to vertical tubes, are presented and mention made of the correlation of these results with theory. The main series show the influence of tube diameter, pressure and heat-input rate on circulation velocities, and additional tests indicate the effects of restricting orifices in the circuit, non-uniform heating of the riser, shortening the heated length and rapid drop in boiler pressure. It is stated that, under steady operation, natural circulation is more than adequate to deal with the maximum heat loading and evaporation rate attained in the tests; tube diameter has an important influence on circulation rate at all conditions within the range studied, the maximum circulation velocities attained for 2¼in, 1¾in and 1¼in tubes being about 5ft, 4ft and 3ft per second. At pressures above 400 lb per square inch and heat-input rates in excess of 40,000 B.Th.U. per hour per square foot, changes in pressure and heat-input rate are shown to become relatively less important and the tests also show that non-uniformity of heating around the riser tube is unimportant, while the rate of drop in pressure to produce circulation failure is related to boiler pressure and to the circulation velocity obtaining before pressure drop occurs.

Liverpool Steam Ship Owners' Association

The annual report for 1957 of the Liverpool Steam Ship Owners' Association records that the Association is entering its hundredth year. It started with six firms which entered 70,000 gross tons of shipping. At the time steam was taking the place of sail and owners had to create a fleet of steamships to meet expanding trade requirements. The report states that progress during the first half-century was such that half of the world's overseas trade was carried in British ships. In contrast, the second half of the century was a period of violent disturbance of trade and difficulties caused by the restrictive trade policies adopted by various Governments. The position, the report continues, was aggravated by the formation of subsidised national fleets which made available unwanted additional tonnage. Another factor which influenced development was the movement of population and centres of industry.

However, at the end of the Association's first century, Liverpool is the second principal port of the country, and figures given show that the tonnage of vessels entered and cleared in foreign trade rose from 4,935,850 tons in 1857 to more than 30,000,000 tons in 1956, while the trade of the port increased in value from approximately £100 million to £1620 million and the weight of exports and imports rose from 3,250,000 tons to 13,637,793 tons. During the century membership, it is recorded, attained a total of sixty-seven and the tonnage entered reached a total of 4,631,240 tons. The report goes on to point out that members have adopted improvements in design to maintain competitive efficiency and emphasises that progress has been made by private enterprise without State assistance. Furthermore, it is asserted, neither State aid nor control can in any way supplant individual skill, ability and enterprise.

Progress of the Dartford-Purfleet Tunnel

A year ago, the main underground drives of the Dartford–Purfleet tunnel were started. This work was inaugurated by the Parliamentary Secretary to the Ministry of Transport and Civil Aviation, and we described the scheme in some detail on that occasion (The Engineer, April 5, 1957). Now, the Ministry has given details of the progress made during the past year on this £11,000,000 scheme. The principal progress figure is that of footage of the tunnel completed—730ft.

Disposal of excavated material in the tunnel is highly mechanised. It is picked up by duck billed loaders, working behind the shield, and deposited on to shaker conveyors, which are lengthened as the tunnel grows. These conveyors shake the material back on to belt conveyors which load it into crushers. The crushed chalk and flint is mixed with water and pumped to the surface, where it is allowed to settle, and is incorporated in flood banks which protect the tunnel entrances.

The shield on the Kent side started first and in June of last year it was freed from the chamber in which it had been built. Throughout the work the pressure has to be maintained at between 15 lb and 27 lb per square inch. The Kent shield has now moved forward 500ft and it will travel a further 1000ft towards the Essex shore. It has left the difficult mixture of gravel and chalk in which it started and is now driving into the chalk at some 80ft per month. On the Essex side the shield was free from the shield chamber in October of last year and has moved 230ft forward. It has about 1070ft to go before it meets the other shield. It is still in awkward terrain and has some 300ft to go before it enters solid chalk.

To complete the tunnel, which will be 4688ft long, it will be necessary to excavate between the two chambers at the bottom of the working shafts and the tunnel portals. On the Kent side this will be done by shield tunnelling for a length of 900ft and by "cut and cover" for 300ft. Work is to start shortly on the erection of a third shield in the chamber from which the existing shield started its journey. On the Essex side, a 500ft length of tunnel from the original shield chamber toward the tunnel portal will be formed by driving three small diameter tunnels and merging them. The remainder will be done by the "cut and cover" method. While the under-river work has been going on, a start has been made on the main ventilation shaft on the Kent side. A caisson is being sunk and, here again, compressed air is being used.

Edmund Nuttall, Sons and Co., Ltd., is the contractor for the tunnel. Completion of the tunnel itself is expected in about two years' time, but there will remain the jobs of forming the inner lining, constructing the road through the tunnel, and completing the ventilation system and other services. Work on the approach roads is expected to start this summer and traffic may be able to use the tunnel and the roads linking it to A.13, in Essex, and A.2, in Kent, in 1962. The consulting engineers for the scheme are Messrs. Mott, Hay and Anderson, and Messrs. Coode and Partners.

Prefabricated Railway Stations

A prefabricated station building has been developed by the London Midland Region of British Railways, and is to be used, initially, in the modernisation of eleven stations between Crewe and Manchester and seven stations between Crewe and Liverpool. Erection has already begun at East Didsbury, Heald Green and Burnage stations, near Manchester.

The new buildings are made from standardised components of steel, aluminium, wood, plastic and special compositions. The components can be adapted to varying shapes of building, and the light weight of the buildings leads to economies in the supporting structures which are necessary at difficult sites, such as on narrow embankments. A primary advantage aimed at in the design, is that of quick erection; on the lines due for electrification a large number of buildings will need to be erected in a short time. To allow for the high-speed running planned with electrification, tracks have to be raised on a deeper bed of ballast, so many platforms and station buildings are then at the wrong level. Existing buildings were also found to be old and unsuited to the new operating requirements, and complete reconstruction was the best solution.

The prefabricated design attempts to embody speed and ease of erection, economy in cost and maintenance, and flexibility, allowing alterations and additions to be carried out to buildings at a later date. A planning module of 40in was adopted. The principal elements of the buildings are: the structure, in steel or aluminium or both; walling, in composition or enamelled metal cladding; partitions, in composition panels, plastic, bonded material; and roof, a flat timber diaphragm. Erection can be completed with all main services in two months.

Power-Operated Manipulator

A REMOTE-CONTROLLED power-manipulator which is believed to be the first of its kind designed and produced in Europe has been developed by The General Electric Company, Ltd., in the company's Atomic Energy Division at Erith, Kent. This manipulator was built mainly for use in nuclear energy establishments, where toxic and radioactive materials must frequently be handled, but it is equally applicable, for example, in certain chemical plants where poisonous atmospheres or hazardous processes are involved.

As illustrated here, the power-manipulator is the mechanical equivalent of a human arm and hand, but it is, in some ways, capable of a greater range of movements than its human counterpart ; in addition, it can carry heavier loads and can maintain a given position over long periods. For example, it can lift and accurately position objects weighing as much as 750 lb, handle delicate glassware without breakage, pour and stir liquids, and wield a large variety of hand and power-operated tools.

Operation of the manipulator is fully controlled by one person from a small console which is readily movable and can be conveniently positioned to suit the viewing arrangements. Unlike the hand-operated manipulators commonly used for light handling duties, there is no mechanical linkage between the machine and the console, the only connections consisting of multi-core electric cable. There is, therefore, no limitation on the distance between the power manipulator and the operator as long as some means of remote viewing, such as closed-circuit television, is available.

The main design requirements were reliability, ease of maintenance, and compactness, to limit headroom required and economise in cell shielding ; special attention has been paid to resistance to gamma radiation of all non-metallic parts such as electrical insulators, lubricants and paints.

Briefly, the manipulator consists of a grasping device carried on a wrist, capable of continuous rotation, which is supported from a forearm, upper arm and shoulder. The arm joints are designed so that each section can rotate through 180 deg. about its pivot, while the shoulder joint can rotate continuously about a vertical axis.

The shoulder is mounted in the base of a set of vertical telescopic tubes, the upper section of which is rigidly fixed to a crane-type carriage. This carriage can be traversed across a gantry spanning the working area and travelling on longitudinal rails mounted near the top of the walls of the cell. The gantry also supports a 1½-ton electric hoist with a cross-traverse parallel to that of the manipulator carriage. This hoist can be used for normal lifting duties and for supporting equipment on which the manipulator is working.

The telescopic tubes, which are housed in the carriage when in their stowed position, have a positive raise and lower action, the sliding movement between tubes being taken on anti-friction bearings running on stainless steel paths. The driving motor for the tubes is mounted in the carriage.

Three drive units are housed in the lowest tube ; one is for shoulder rotation, one for the shoulder pivot by which the upper arm is moved, and one for the elbow pivot which controls the movement of the lower arm. The drives to the two pivots are transmitted through sets of gears mounted in the shoulder casting, followed, in the case of the elbow pivot, by a train of spur gears inside the upper arm. A twenty-way slipring column, through which the electrical connections to the rotating section of the manipulator are made, is also housed in the lowest telescopic tube.

On the lower arm there are two drive units, one for the wrist which gives continuous rotation in either direction, and the other for the grasping device. Two such devices are normally supplied. The more versatile of these takes the form of a hand with two jaws capable of a maximum opening of 5in and of applying a gripping force of any value up to 150 lb. The jaws are opened and closed by means of a parallelogram linkage driven by a rack which, in turn, is coupled to the drive unit by a differential gear. The torque on the arm of this gear is used to provide an indication of the grip-pressure applied by the jaws, a spring deflected by movement of the arm being arranged to actuate a transducer. The alternative device, which is mainly used for lifting duties, is a hook which can be driven against an anvil. The same drive unit is used for both the hook and the hand.

The grasping devices can be interchanged remotely. The device already attached to the manipulator is driven into a fixture which grips it firmly and, at the same time, releases a locking ring on the wrist. The wrist is then rotated until the device frees itself. The other device, which is housed in another fixture, can then be attached to the manipulator by carrying out the reverse process.

The basic elements of the manipulator can be assembled in a variety of ways to fit different sizes of cell, and can be arranged for other forms of mounting than that of suspension from a crab moving in a horizontal plane.

Electrical Drives and Connections

To give the machine the longest possible life under the effects of gamma radiation, the use of organic insulating materials has been avoided, as far as possible, in the electrical equipment. As the operator can at all times see the manipulator, either directly or through some remote-viewing device, he is given

Power-operated manipulator erected for testing in a mock-up cell for the handling of radioactive materials

control of the speeds of movement of the various components rather than direct control of their actual positions. He can vary the speed of each motion over a range of 8 to 1.

All the motions are powered by variable-frequency, three-phase, squirrel-cage induction motors which require no brushgear, and no insulating material is needed in the rotors. The wire in the stator windings is insulated with silicone and glass and the slots are lined with mica ; the solid insulation is made of silicone-bonded glass laminates.

The small motors used for powering the arms of the manipulator are fitted with integral electromagnetic brakes which operate from the motor flux. The brake linings are of phenolic-bonded asbestos which was chosen for its resistance to gamma-radiation damage. The larger motors for the long-travel, cross-traverse and telescopic-tube drives are provided with separate shoe brakes with silicone-and-glass insulated coils. All of these brakes are essentially for holding, to stop movement in the event of a power failure. There are limit switches at both ends of the travel of each component to prevent damage to the machine by over-running.

The wiring of the manipulator is done in a specially selected P.V.C. cable, P.V.C. being used in preference to polyethylene insulation because it remains more flexible up to quite high gamma-radiation dosages. The connection between the head and the base of the telescopic tubes consists of a self-coiling multi-core cable which is normally stored in a cylinder at the base of the tubes. Those cables that are most likely to sustain damage are equipped with plugs and sockets so as to facilitate replacement. The plugs, the sockets, and the enclosures of the motor terminals are suitable for hosing with water, while they are live, for decontamination. The twenty-way slipring column in the lower telescopic tube is fabricated entirely from "Micalex." All connections are made by silver-graphite brushes rubbing on silver sliprings, two brushes being used per ring.

The electrical supply to the manipulator is carried by a P.V.C. multi-core cable resting on sheaves mounted at intervals along the side of the gantry track. A weighted take-up pulley is employed as a means of storing the cable.

The variable-frequency supply for the manipulator driving motors is obtained from small motor-alternator sets which are housed, together with their associated control gear, in a separate floor-mounted cubicle. The alternators, which have a fixed excitation, are driven by variable-speed d.c. motors. Speed variation is obtained by means of magnetic-amplifier control in the armature circuits, the resulting outputs ranging from 14V to 110V and from 12·5 c/s to 100 c/s. The control windings of the magnetic amplifiers are fed from potentiometers which are coupled to two joysticks mounted in the front face of the control console.

All the movements of the manipulator are controlled by these two joysticks. The joystick handles have simultaneous freedom of motion in four directions, each direction being associated with a corresponding movement of one of the manipulator components. The degree of displacement of the joystick is proportional to the speed of the corresponding manipulator movement. All motions of the joysticks are arranged to follow logically those of the manipulator so that a relatively unpractised operator can control the machine with ease. Control for the hand or hook has been designed so as to permit adjustment of both the closing speed and the grip-force. These two properties are incorporated in one joystick motion so that low grip-force is associated with low speed, since a high speed of closing on to a delicate object is not a natural requirement.

The outward thrust or grip-force between the hand jaws is indicated on an instrument mounted on top of the console. This instrument is non-linearly scaled from 0 lb to 150 lb so that the 15 lb graduation is in the midscale position, thus ensuring adequate sensitivity of indication when handling light or fragile objects. A further indication of grip-force is provided in the form of an audible signal from a variable-frequency oscillator so that the operator can, when necessary, concentrate on watching the manipulator. Switches for controlling the hoist block and for locking any of the manipulator motions in a given position are provided on the top of the console.

Ceramic Tool Tips.—Ceramic tool tips now being marketed by Verrolec, Ltd., Balfour House, Finsbury Pavement, London E.C.2., are ¼in square by ⅛in high and are designed for use of all eight edges. The lathe tool holder into which the tips are mechanically clamped is designed to impart a rake and sideslope of 6 deg., and the tools must be set to cut 0·4 to 0·5mm below centre to ensure that they do not vibrate against the work. With these "S.P.K." tool tips, the firm states, under the specified conditions, cast iron can be turned at three times the normal speed and steel at twice the normal speed used with tungsten carbide tips.

Industrial and Labour Notes

Wage Claims

On Thursday of last week, the Industrial Court's findings on the London busmen's wage claim were announced. The Court recommended an increase of 8s. 6d. a week for bus and trolleybus drivers and conductors in Central London. There was no mention of any increase for maintenance workers in the garages or drivers and conductors on London Transport's country services. Shortly after the Court's decision was made known, the Minister of Transport, Mr. Harold Watkinson, said that if the parties agreed to implement the award, the situation must conform with the Government's " beat the inflation " economic policy. Thus it must be met not by increasing general travelling costs but by making all possible internal economies and by increasing efficiency. On Monday, the London Transport Executive met representatives of the Transport and General Workers Union to discuss the award but no agreement was reached. The London Transport Executive indicated that it could not go beyond the terms of the Court's award. It has been stated that a delegate conference of the busmen is to be held to consider the next move.

Another wage claim has been further examined this week. On Monday, the Railway Staff National Tribunal began its investigation of demands submitted on behalf of all grades of British Railways' employees. These demands have been made, individually, by the three railwaymen's unions and have already been rejected by the British Transport Commission. The National Union of Railwaymen has asked for a " substantial increase," the Associated Society of Locomotive Engineers and Firemen for a 10 per cent increase, and the Transport Salaried Staffs Association for an unspecified amount to maintain the purchasing power of salaries.

The Forty-Hour Week

When the executive of the Confederation of Shipbuilding and Engineering Unions met last week, it considered the rejection by the shipbuilding and engineering employers of the claim for a forty-hour week without any loss of pay. The decision reached was that the executive should seek further meetings with the two employers' organisations concerned and put forward the suggestion that a forty-hour week should be introduced by progressive steps over an agreed period.

The claim for a forty-hour week was formulated last autumn following a resolution passed at the annual conference of the Confederation of Shipbuilding and Engineering Unions. That resolution authorised the executive to recommend such action as it might consider necessary, including an overtime ban, in pressing the claim. It has been stated that last week's resolution suggesting the introduction of the forty-hour week by progressive steps contained a recommendation that, if satisfaction was not gained, the Confederation's executive should again discuss " the implementation of the 1957 annual conference resolution."

Employment and Unemployment

According to the Ministry of Labour's latest report on the employment situation, the number of people in civil occupations in Great Britain at the end of January was 23,096,000 (15,306,000 men and 7,790,000 women). This was 35,000 below the figure returned at the end of last year. The January total included 3,924,000 in the basic industries, 9,284,000 in the manufacturing industries and 9,888,000 in other industries and services.

In the manufacturing industries, there was an overall decline during January of 16,000. It was spread over most of the groups although there was increased employment in clothing manufacture and vehicle building. In the latter group, there was an addition of 3000 bringing the number employed to 1,252,000. In "engineering, metal goods and precision instruments" the labour force declined by 2000 during January bringing the total number at work to 2,845,000, compared with 2,830,000 a year earlier. In " other industries and services " the biggest changes in January were in building and contracting and in the distributive trades. The figure for building and contracting declined by 11,000 to 1,459,000 ; in January last year the employment total was 1,508,000. In the manufacturing industries, the number of operatives working short time in the week ended February 1, was 82,000 which was 2000 more than in the preceding month.

The Ministry's report says that, in the five weeks ended February 12, the employment exchanges filled 184,000 vacancies. The number of vacancies notified to the exchanges but remaining unfilled on February 12, was 209,000 which was 11,000 less than in January. As to unemployment, the report states that on February 17 there were 424,547 people registered as out of work, compared with 395,527 a month earlier. The February figure, which represents about 1·9 per cent of the total number of employees, included 392,820 wholly unemployed and 31,727 who were temporarily stopped.

Industry's Expenditure and Stocks

The Board of Trade has made some provisional estimates of capital expenditure by manufacturing industry in the fourth quarter of last year. These estimates indicate that capital expenditure was about 2 per cent higher than a year earlier. This compares with increases of 13 per cent, 9 per cent and 5 per cent respectively during the first three quarters of 1957. In the final quarter of the year, the rate of increase of expenditure on plant and machinery was much the same as in the third quarter, the smaller total increase being accounted for mainly by a larger decrease in expenditure on building.

The Board of Trade has also made a provisional assessment of the value of stocks and work in progress in manufacturing industry in the fourth quarter of 1957. The indications are that there was no appreciable change from the third quarter. The Board says that this estimate must be compared with an increase of 2 per cent during the third quarter of 1957 and of 1½ per cent in the final quarter of 1956. The Board adds that this is the first time, since quarterly returns were instituted at the end of 1954, that there has been no increase in the total value of stocks. The estimate of no change in the total for the fourth quarter has been arrived at on the basis of there having been small increases in the value of materials and fuel and finished goods and a decrease in the value of work in progress. The provisional estimate of the change in the value of stocks and work in progress in manufacturing industry between the beginning and end of last year is of an increase of about 8 per cent ; the increase over the whole of 1956 was of the order of 10 per cent.

Iron and Steel

Steel production in February averaged 427,500 tons a week, compared with 407,100 tons in January and 432,100 tons a week in February last year. Pig iron production in February was at the rate of 272,700 tons a week ; in January it averaged 271,000 tons a week and in February last year 267,600 tons a week.

The Iron and Steel Board says that steel-making capacity is expected to increase further during the course of the present year. There should be capacity available for the production of 23,500,000 tons of steel this year on a fifty-three week basis, or 23,200,000 tons on a fifty-two week basis. This means that capacity in 1958 is expected to be 1,500,000 tons higher than the actual production in 1957. The Iron and Steel Board makes the point, however, that production this year is likely to be determined more by demand than supply considerations, apart from strip mill products and heavy plate ; the demand for these descriptions still exceeds the supply from home sources.

The Board has now assembled statistics of finished steel consumption in the United Kingdom last year. Over the whole year, consumption amounted to about 13,575,000 tons, which was virtually the same as in 1956. In the final quarter of last year, however, consumption was approximately 4 per cent higher than in the comparable period of 1956. It should be noted that during 1956 the trend of consumption was downward, largely on account of some recession in the motor-car and durable consumer goods industries. In the latter half of last year steel consumption by these industries recovered sharply.

Future of the Steel Industry

At the annual general meeting of the British Iron and Steel Federation, on Tuesday, the president, Sir Andrew McCance, commented on the Labour Party's proposals for the future of the steel industry. The industry's future policies, he said, were based on its solid achievements since the war ; steel output had risen by 75 per cent and productivity by 40 per cent. An average of £2,000,000 a week was now being spent on development. Exports of steel and goods made from steel, Sir Andrew continued, represented more than half the total value of British exports and this country's steel prices compared favourably with overseas prices.

Yet, Sir Andrew commented, all this was overshadowed by a threat of nationalisation. The industry had on occasion been accused of inefficiency, but all standards of comparison proved the contrary. It had been alleged, Sir Andrew went on to say, that the industry lacked proper check or supervision and that public ownership was therefore necessary for the economic planning of the nation's affairs. But the industry had, in fact, worked for many years in the closest co-operation with the Government of the day, and all targets in the post-war development plans had been discussed and agreed with the Government irrespective of political persuasion. Moreover, the industry was under the constant and effective supervision of a strong and independent Iron and Steel Board appointed by the Government.

Leipzig Spring Fair

AT the Leipzig Spring Fair, which took place during the period March 2–11, over 9600 exhibitors from forty-three countries were represented. The Fair is broadly divided into a sample fair, to which were devoted seventeen pavilions and sixteen buildings, and the technical fair with twenty-two halls and an open-air space. Of the total exhibition area of 290,000 square metres, the technical fair occupied 190,000 square metres, of which 110,000 square metres were under roof and 70,000 square metres in the open. While the strongest contingents were provided by the two German states (about 6500 industrial undertakings from the German Democratic Republic and 1450 from the German Federal Republic), the international character of the event was well evidenced by collective exhibits from the U.S.S.R., China, Bulgaria, Poland, Hungary, Czechoslovakia, Yugoslavia, Belgium, Denmark, Finland, France, Great Britain, the United Arab Republic (Egypt), the United Arab Republic (Syria), Greece, India, Morocco, Austria, Norway, Columbia, Argentina, Uruguay and Spain. As regards the technical fair, pressure on space had to be met by reducing the area originally allotted to East German exhibitors by cutting down the showing of standard lines and concentrating on special items and new designs.

The interest which the Leipzig Fair is again beginning to attract is due to two main factors. By long tradition—the sample fair goes back to the early thirteenth century—Leipzig, on account of its geographical position, is important as a meeting place of East and West, an aspect which is accentuated by the present political division. Secondly, the continuing improvement in East Germany's economic position is increasing the country's importance as a trade partner. The volume of trade with the eastern countries last year increased by 25·4 per cent, while western trade grew by 23·7 per cent, as compared with 1956. Production in 1957 is stated to have been two-and-a-half times greater than in 1950, making East Germany the fifth largest producer in Europe. Foreign trade last year amounted to some 13,500 million roubles, compared with nearly 11,000 million in 1956, and 3500 million in 1950.

Among over 100 British firms which took part in the Leipzig Spring Fair were Imperial Chemical Industries, the Guest, Keen and Nettlefolds Group, Marconi, Pye, Rolls-Royce (oil engines), Rootes, Rover, Standard Motor Company, Massey-Harris-Ferguson, and the Brush group.

The largest section of the technical fair, 281,000 square metres, was taken up by a very full representation of East German industry. Of foreign participation, the largest was that of the Soviet Union, which exhibited in its own pavilion

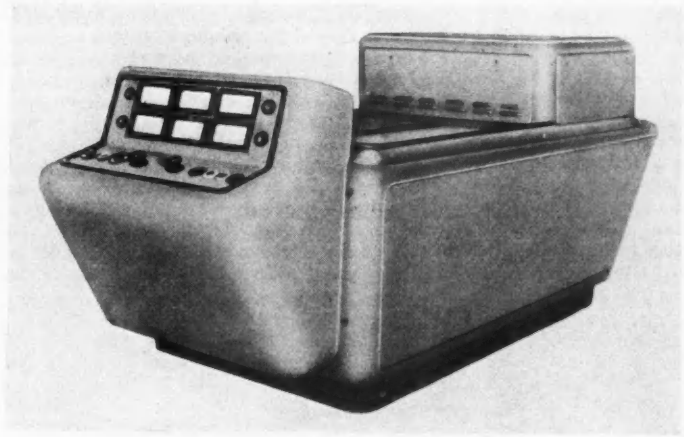
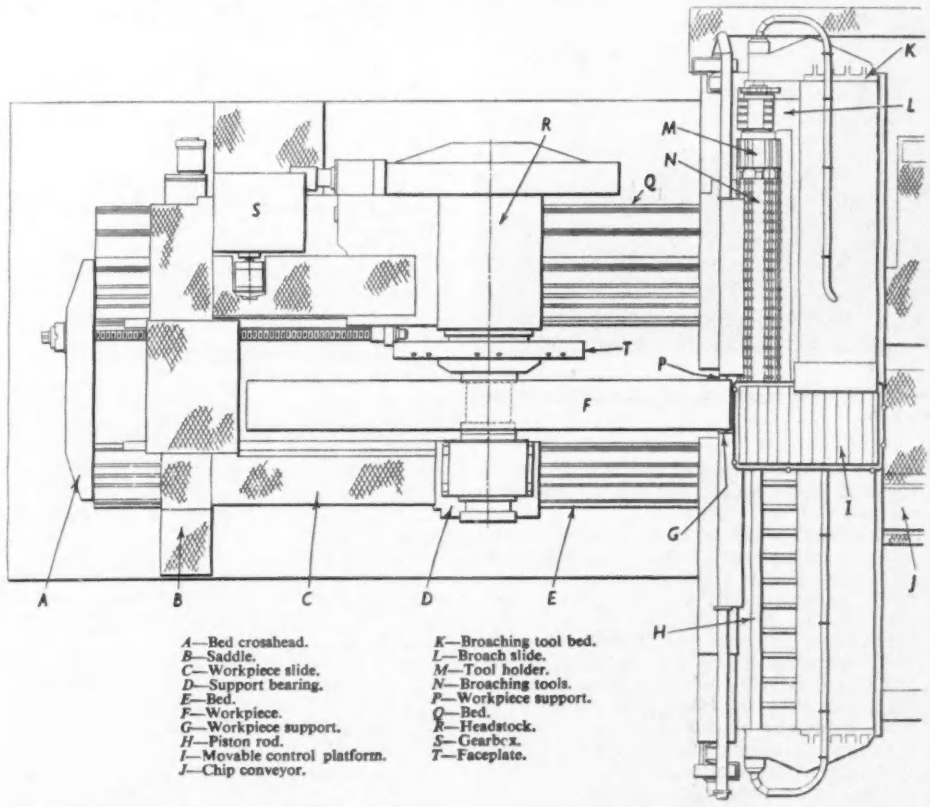


Fig. 2—Automatic heat-treatment plant for roller bearing races. The central portion contains the oil bath, top right is the medium-frequency heating coil; on the left, the control panel—Veb Elektromotorenwerk Göllingen

a cross-section of its production of consumer as well as capital goods; the second largest was that of Czechoslovakia. It is beyond the scope of this article to attempt a complete survey and in what follows we mention a few selected items which may be of interest to our readers.



A—Bed crosshead.
B—Saddle.
C—Workpiece slide.
D—Support bearing.
E—Bed.
F—Workpiece.
G—Workpiece support.
H—Piston rod.
I—Movable control platform.
J—Chip conveyor.
K—Broaching tool bed.
L—Broach slide.
M—Tool holder.
N—Broaching tools.
P—Workpiece support.
Q—Bed.
R—Headstock.
S—Gearbox.
T—Faceplate.

Fig. 1—Broaching machine "ZRZ 7100×50" for the rapid production of gear wheels up to 7·1m diameter

Particular attention was aroused by the pavilion of the now two-year-old East German aircraft industry, which exhibited, in model form, two passenger airliners, as well as full-size engines for these aircraft, two designs of high-performance gliders, and a number of components, instruments and accessories.

One model represented the "IL-14P," of which an actual example had already been shown last year. This twenty-six-seater airliner, of 17,000 kg all-up weight and 12,100 kg empty weight, has a span of 31·7m, is 21·3m long and 7·9m high, and has a wing area of 100 square metres. Powered by two "ASch 82T" fourteen-cylinder radial engines driving four-bladed "AW-50" variable pitch propellers of 3·8m diameter, the aircraft is designed for a cruising speed of 320km per hour and has a service ceiling of 6500m. Fitted with a tricycle undercarriage, it is a development of the well-known Russian "IL-14" eighteen-seater. It is now in service with the East German "Lufthansa" and Polish airlines.

The "ASch 82T" engine which was also shown is, as will be recalled, a 2×7-cylinder air cooled radial design giving 1873 b.h.p. at 2600 r.p.m. and weighing 1080 kg.

The other machine, of which the prototype is nearly completed, is the forty-eight to seventy-two-seater, normally fifty-seven-seater, jet aircraft "152," of which a freight version is also planned. Destined for intermediate ranges of 1000–3000km, it will travel at 800–850km per hour at heights of 10–1200m. Principal dimensions are length 31·40m, height 9·12m, span 26·80m, and wing area 138 square metres. It has a maximum all-up weight of 46·5 tonnes, with a useful load of 5·5 tonnes and is powered by four "014" jet engines of 3150 kg starting thrust. The "014" engine, of which one complete version and various subassemblies were shown, has a twelve-stage axial compressor, annular combustion chamber with twelve burner chambers, and a two-stage turbine. Its specific consumption for a static thrust of 3150 kg is stated to be approximately 0·85 kg per kilogramme-hour. Both the aircraft and its engine are stated to be entirely new designs.

The two gliders shown are in series production. They were the "Libelle" 16·50m span, single-seater (all-up weight 230 kg), and the "Lehrmeister" two-seater of 17m span, with a maximum all-up weight of 480 kg.

A 120-ton C_0-C_0 electric goods and express locomotive, the "E05–30," was shown by V.E.B. Lokomotivbau und Elektrotechnische Werke "Hans Beimler," Henningsdorf/Berlin (V.E.B. = Volkseigener Betrieb, "nationally-owned undertaking"). This is a development of another L.E.W. locomotive, the "E05–2," of which a model was shown and which in turn has been developed from a B_0-B_0 locomotive. The "E05–30," of which thirty were delivered last year to Poland, has a length over buffers of 18,700mm, a width of 3050mm, and height above rails of 4480mm. Its six motors develop 3180kW and a pull of 22,500 kg (both hourly ratings). Designed for a maximum speed of 120km per hour, its starting pull is 36,800 kg. The bogies are a kingpin design. For starting, all six 1500V d.c. motors are placed in series; during running three pairs of motors are operated from the 3000V overhead wire.

Shown as a model was the "EL 1/01" 150-ton B_0-B_0-B_0 heavy goods locomotive, built for the U.S.S.R. This engine has an hourly rating of 6×350kW, 24 tonnes pull. Maximum speed and starting pull are, respectively, 65km per hour and 30 tonnes. The engine has a twin frame, each

half being hinged to the central bogie, and in this way is a development of an earlier design with three linked superstructures.

A very full range of East German machine tools was on view, among them many new developments. V.E.B. Zahnschneidemaschinenfabrik Modul, Karl-Marx-Stadt, showed an automatic gear and worm wheel milling machine for gears of 200–2000mm o.d., and up to module 20, equipped with twenty-four feeds from 0·0315mm to 6·3mm per one revolution of the workpiece. The machine is also suitable for internal gear milling by means of end mills.

The same firm exhibited the model of a very large gear broaching machine for straight spur gears of up to 7100mm outer diameter and for a range of modules from 15 to 50. The machine, the "ZRZ 7100×50," of which the prototype is in Magdeburg, can cut teeth up to 700mm wide in wheels up to 1100mm wide (Fig. 1). The broaches are arranged on the faces of a hexagonal prismatic drum which is hydraulically operated at speeds which are infinitely variable between 0·5m and 15m per minute. The stroke of the tool carrier is 3600mm and the maximum cutting force is 50 tonnes. For setting up, spindle speeds of 0·1 to 0·25 r.p.m. have been provided, while the hydraulically unloaded work carrier for workpieces of up to 130 tons can move on its bed with speeds of 150mm per minute for coarse and 12mm per minute for fine adjustment.

Cutting is carried out on both the forward and reverse stroke of the tool carrier, successive sets of broaching tools being arranged to face in opposite directions. After each stroke the tool carrier is indexed and the workpiece fed in for the next cut, the cutting depth amounting to 0·1mm to 1mm. During cutting, the workpiece is clamped by hydraulically operated toggles. Operation is programme controlled, and a bucket conveyor has been provided to convey the large quantities of chips from underneath the machine into trolleys. Output is stated to be three to four times that obtainable by milling; the accuracy attainable is claimed to be IT9 to 11, satisfactory for such applications as, for instance, rings for cement kilns.

A jolt-squeeze turn-over moulding machine was shown by V.E.B. Giesserei und Maschinenbau "Ferdinand Kunert," Schmiedeberg (Bezirk Dresden). This machine is available for semi- or fully automatic operation, with pneumatic sequence control. It comprises a bed on which a vertical arm is mounted which can be turned through 180 deg. about a horizontal axis. This arm carries at one end the moulding table and its operating air cylinder, at the other the pressure cross-head which can swing into and out of position about a vertical axis. Operation comprises the following stages: jolting; swivelling-in of the cross-head and squeezing, turning, vibrating and beginning of lifting, lifting; turning back and swivelling cross-head out of position. Each of the three main stages is initiated by a push-button. Overlapping of some of the operations reduces the overall time substantially. The bearing of the turn-over shaft is protected during jolting by a supporting device.

In the field of grinders, Technoimpex, P.O.B. 183, Budapest 62, showed the "LKO2" surface grinder, specially designed for the accurate machining of surfaces which are inaccessible to the ordinary machine. The model "LKO2" comprises a directly-driven grinding spindle, mounted on a horizontal arm with 660mm overhang to centre of the spindle, in such a way that the head can be swivelled about two axes which are, respectively, parallel and perpendicular to the arm. The arm itself can be raised and lowered on a column by a rack and pinion drive over 520mm, with additional fine adjustment over 25mm. The column is mounted in a cee-shaped casting provided with a flat base measuring 680mm by 460mm. By means of an air cushion operating from the normal compressed air supply (5–6 atmospheres), the grinder can be floated on a surface table and can readily be moved about by means of two handles fitted to the base. Extensions for the grinding spindle are supplied with the machine.

An electric calculator for the rapid determination of cutting conditions was exhibited by Strojexport, Prague, Czechoslovakia. The instrument possesses eleven dials arranged in three rows of four, three and four dials, and four indicating instruments with central zero point. For determining the cutting conditions for steel and cast iron, when using tungsten carbide or high-speed steel, the lower dials are set to the given conditions of cutting diameter, hardness of workpiece, nature of cut (roughing or finishing of steel, roughing of castings) and material of the cutting tool, cutting angle, cutting depth, feed per revolution, and permissible tool life. By adjusting the dials of the upper row until all instruments read zero, the unknown quantities: cutting speed, driving power, revolutions per minute, and time to machine a length of 100mm, can be read off. The instrument measures 430mm by 500mm by 195mm and is designed for connection to 220V, 50 c/s, single phase.

For hardening ball and roller bearing races, V.E.B. Elektromotorenwerk Göllingen, Göllingen (Kyffh.) exhibited a fully automatic machine, illustrated in Fig. 2, which operates with a medium frequency of 8000 c/s for small races down to 10mm diameter, and 2400 c/s for the larger sizes. The workpieces arrive on a chute and are pushed one after the other at intervals of about fifteen seconds into the heating coil, the length of which is given such a value that the required minimum soaking time is reached. The races are eventually pushed out at the far side of the coil and roll over a chute into the oil bath, the length of the chute being such that the workpieces are cooled below the transformation point before falling on to a conveyor which removes them from the machine. Numerous controls permit the maintenance of correct conditions.

K. and L. Steelfounders and Engineers, Ltd., Letchworth, Herts, exhibited for the first time the Jones "KL 10–10 travelling crane" (Fig. 3). This crane has a single power unit for driving the crane on the road, at speeds of up to 48km per hour, as well as for its operation. This is a Leyland "O.600" diesel engine, giving an output of 125 b.h.p. at 1800 r.p.m. The transmission is through a five-speed gearbox and differentials to either the four rear wheels or all six wheels. Steering is power-assisted. All wheels have compressed air brakes, the compressed air system also serving to inflate the tyres when necessary. At each side of the frame two supporting jacks are fitted. When these are being used, loads up to 12,500 kg can be raised at a radius of 3·1m. Hoisting speeds are 30m, 15m and 10m per minute, depending on whether single, double or triple purchase is being applied. Full circle slewing can be carried out in twenty-four seconds. The chassis has a turning circle of 12·2m. Gradients up to 1 in 6 can be negotiated without load. The crane controls can be operated from inside the driving cab from a second, rearward-facing seat equipped with a duplicate set of driving controls.

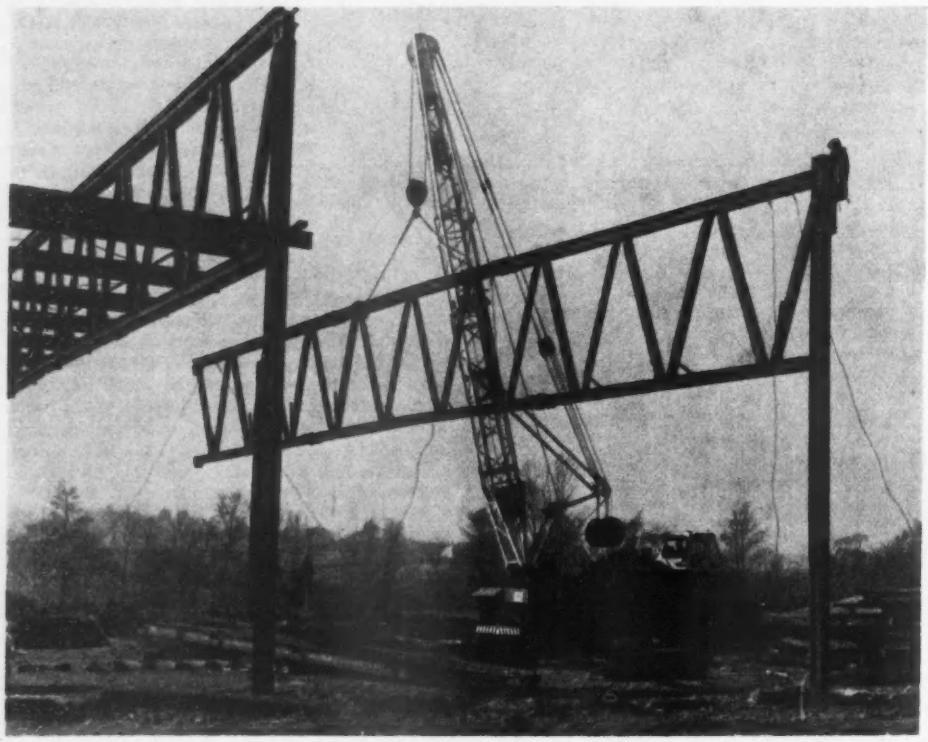


Fig. 3—12·5-ton auto crane: crane and wheels are driven by the same engine—K. and L. Steelfounders and Engineers, Ltd.

British Trade Fair at Lisbon

A British Trade Fair is to be held in Lisbon from May 29 to June 14, 1959. It will be organised by British Overseas Fairs, Ltd., on behalf of the Federation of British Industries, and will be held in Lisbon's new and well-equipped Exhibition Hall, which has been used for only one previous exhibition. Britain is Portugal's best customer, and traditionally Britain has always been the principal exporter to Portugal, but recently Germany has taken the lead in the Portuguese market, though she buys from Portugal only a relatively small proportion of goods in return. The time is therefore considered ripe for a special endeavour by British industry to regain the lead in the Portuguese market.

Research Reactor "EL.3"

It is announced that the research reactor "EL.3" of the Centre d'Etudes Nucléaires, Saclay, France, reached a thermal output of 10MW on March 8. This is a materials testing reactor, the installation of which completes the range of materials testing facilities at the C.E.N. in particular. It is a ten times more powerful source of neutrons than the "EL.2," which has been functioning since 1952. For this reason, it is possible to carry out test at ten times the speed previously possible; the reactor will also produce radioactive isotopes, a thing which the "EL.2" could not do.

The "EL.3" has been in operation at a low level of output since July 4, 1957. On December 22, an output of nearly 3MW was reached. At the level attained on March 8, over 8×10^{13} neutrons per square centimetre per second were emitted, placing this reactor amongst the most powerful of its kind which are known, i.e. not counting the U.S.S.R. It takes third place behind the American M.T.R., which develops 5×10^{4} neutrons per square centimetre per second.

Shippingport Atomic Power Station in Pennsylvania

BY OUR AMERICAN EDITOR

No. I

The first American full-scale atomic power station devoted exclusively to peaceful uses began operation in December, 1957. The station is situated on the Ohio River at Shippingport, Pennsylvania, about 25 miles from Pittsburgh, and was built jointly by the Duquesne Light Company, the Westinghouse Electric Corporation and the U.S. Atomic Energy Commission. The plant employs a pressurised light water reactor and utilises turbo-electric generating equipment of conventional design. The power station is already producing a net output of 60MW and is expected eventually to turn out at least 100MW of electricity.

IN JULY, 1953, the Westinghouse Electric Corporation, of Pittsburgh, Pennsylvania, was given the responsibility by the U.S. Atomic Energy Commission for the development and design of a pressurised light water reactor (" P.W.R.") and a primary coolant circuit intended as the heat source for generating civilian electric power. In October, 1953, the A.E.C. formally announced the award of this contract to Westinghouse and, at the same time, invited American industry to propose ways and means whereby it might participate in the project and help defray the costs involved. In March, 1954, following the receipt and analysis of nine proposals, the Commission announced that an offer made by the Duquesne Light Company, of Pittsburgh, Pennsylvania, was most favourable to the U.S. Government and would be accepted. The offer stipulated that Duquesne would furnish a site for the entire " P.W.R." project, that Duquesne would build an electric generating plant, that it would contribute 5,000,000 dollars toward the cost of the reactor plant, and that it would operate the overall plant at no cost to the U.S. Government. In addition, Duquesne will purchase steam produced by the reactor plant at certain specified rates which vary from 48·3 cents per million B.Th.U. during the first ear to 60·3 cents per million B.Th.U. during the fifth year.

In April, 1954, the Atomic Energy Commission announced that this first large-scale atomic power plant would be built near the village of Shippingport, Pennsylvania, on the south bank of the Ohio River about 25 airline miles from Pittsburgh. The ground breaking ceremony, in which President Eisenhower participated, took place on September 6, 1954. The following general specifications were given to the Westinghouse Electric Corporation at the beginning of the present scheme:—

(1) Generation of at least 60MW of useful electric energy.

(2) Use of a light water cooled and moderated, slightly enriched uranium reactor.

(3) Use of steam conditions of 600 lb per square inch absolute, saturated or higher.

(4) Fuel element life to be as long as possible between chemical reprocessing.

(5) Refuelling to involve only a minimum shut-down period.

(6) Conventional central station steam, electric and auxiliary systems to be employed.

At the initial stage of the present scheme, the company felt that the most serious problem concerned the development and design of the nuclear core. The two major aspects of this problem involved the development of suitable materials for the reactor and the development of basic design data and relationships capable of being used to calculate the nuclear design of the reactor core. Up till 1953, the company knew of no fuel material having corrosion resistance characteristics and radiation stability which showed promise of meeting the conditions laid down in the specifications. It was therefore decided to give priority to the production, testing, and study of many potential fuel materials. A considerable effort went into the development of suitable structural materials and the fabrication of fuel into various shapes. An extensive " in-pile " test programme was established for testing both sample materials and sample fuel elements. This work involved the design, fabrication, and installation of several high temperature, high-pressure test loops for use in the Canadian nuclear reactor at Chalk River and the Materials Testing Reactor (" M.T.R.") at the National Reactor Testing Station in Idaho. The bulk of the effort in the field of reactor design was aimed at developing information necessary to choose a fuel element shape and to establish the thermal design of the reactor. This programme involved preparing a number of different core designs associated with various fuel elements. It involved heat transfer studies to develop the basic data required to prove the design; and, in this respect, use was made of a special fuel element burn-out test loop. In addition, preliminary designs were made of the primary coolant system, including a determination of the number and size of the primary loops required, the methods to be used in constructing individual components, and the preparation of specifications for items requiring extended deliveries.

General Plant Design

The basic diagram of the reactor and the steam plant is shown in Fig. 1. The nuclear reactor as the heat source produces a minimum full power rating of 790×10^6 B.Th.U. per hour. The nuclear core is a right circular cylinder consisting of assemblies of enriched uranium in clad plates and natural uranium in tubes. These assemblies are supported in a bottom plate and top grid, which, in turn, are supported from a ledge of the reactor pressure vessel. This vessel is a cylinder with a hemispherical bottom and a removable hemispherical top closure. Coolant enters through four nozzles at the bottom of the reactor and leaves through four nozzles at the top.

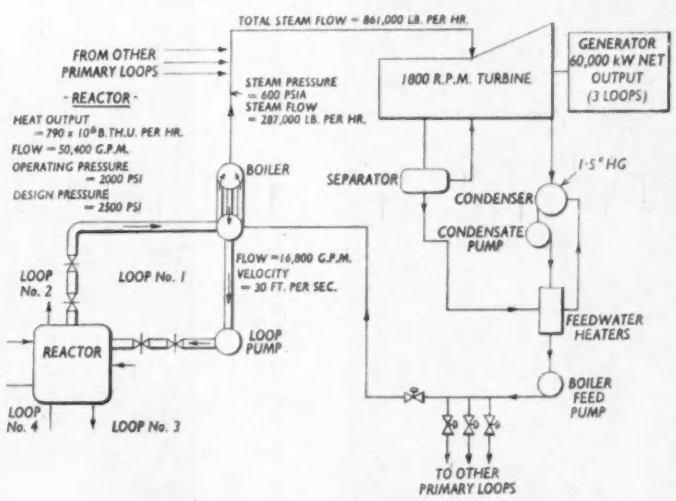


Fig. 1—Basic diagram of nuclear reactor and steam plant

The reactor plant consists of a single reactor heat source with four main coolant loops. Three of these loops are required for producing the 60MW minimum design power of the plant. Each loop consists of a single-stage centrifugal canned-motor pump, a heat exchanger section of a steam generator, 16in gate isolation valves, and the necessary inter-connecting piping of 18in O.D. High-purity light water serves as both the coolant and moderator in this plant. This water is under a pressure of 2000 lb per square inch. The flow through the nuclear core is 45,000 gallons per minute for three loops. At full power the inlet water temperature to the reactor is 508 deg. Fah. and the outlet temperature is 524 deg. Fah. The water velocity in the 18in pipes is approximately 30ft per second with a velocity of between 10ft and 20ft per second in various parts of the nuclear core. The total pressure drop around the main coolant loop is 105 lb per square inch, and this drop is divided about equally between core, steam generators, and piping.

The coolant enters the bottom of the reactor vessel where 90 per cent of the water flows upward between the fuel plates and rods, with the remainder by-passing the core in order to cool adequately the walls of the reactor vessel and the thermal shield. After having absorbed heat as it goes through the core, the water leaves the top of the reactor vessel through the outlet nozzles. It then passes through two 16in isolation valves in series and goes through the heat-exchanger section of the steam generator. The water then flows through the canned-motor pump and back through the inlet isolation valve to the bottom of the reactor, completing the cycle.

Isolation valves are situated immediately adjacent to the reactor inlet and outlet nozzles of each of the four loops. These valves permit the isolation of any loop of the reactor plant, to provide maximum protection to the reactor and to allow maintenance being performed while the remainder of the loops are in operation. The main coolant flows through the inside of many hundreds of small stainless steel tubes in the heat-exchanger section of the steam generators. These heat-exchanger tubes are surrounded by the water of the secondary system, which is heated by the primary coolant in the tubes. Wet steam is formed, which passes upward through the risers and enters the steam-separator portion of the steam generator. Here the moisture is removed and returned to the heat-exchanger section through the downcomers. The dry and saturated steam at 600 lb per square inch absolute at full power leaves the top of the steam separator and goes to the steam turbine.

The selection of the primary and secondary system temperatures and pressures required a compromise of many conflicting factors. To achieve the highest thermal efficiency, steam pressure and temperature should be as high as possible. This gives the most efficient utilisation of the nuclear fuel and also, in the pressure range under consideration, the lowest cost of the steam turbine equipment per kilowatt. In general, the cost of the primary system components increases with pressure, and 2500 lb per square inch represents about the highest practical pressure with present-day technology. Above this pressure the cost of components rises quite rapidly. The nominal operating pressure consistent with a 2500 lb per square inch design pressure is 2000 lb per square inch, for which the saturation temperature is 636 deg. Fah. The maximum metal surface temperature for the fuel selected is, therefore, a few degrees below this value. The cost of a core usually increases with increase in metal surface temperature.

The primary coolant temperature and flow are determined by a proper balance between such factors as the cost of core pumping-power costs and steam generator costs. Increasing the flow of coolant for a given inlet temperature and power causes a decrease in core cost. The higher

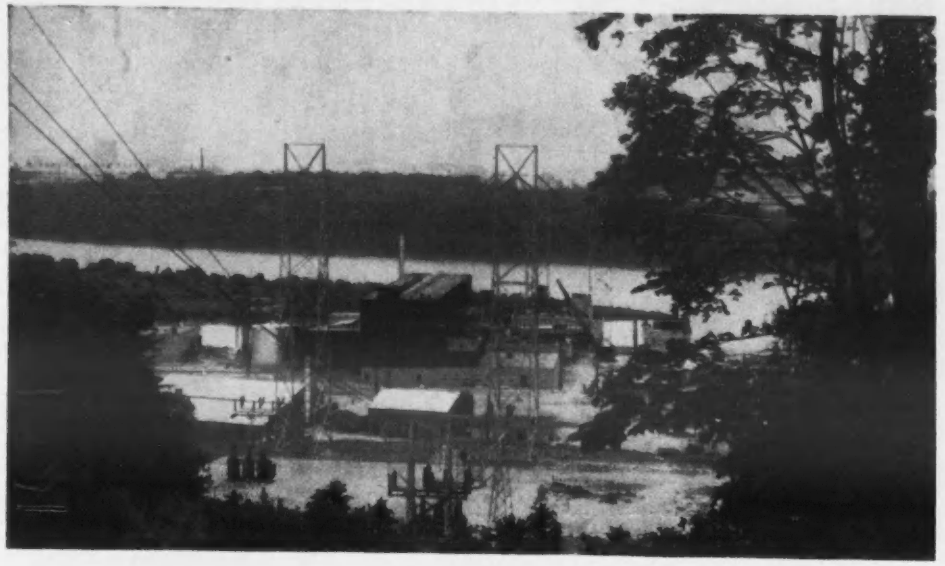


Fig. 2—Shippingport atomic power station, with the nuclear portion of the plant situated in the central tall building

Fig. 3—Reactor pressure vessel of 235 tons dry weight, with a 33ft overall height and an 8½in wall thickness

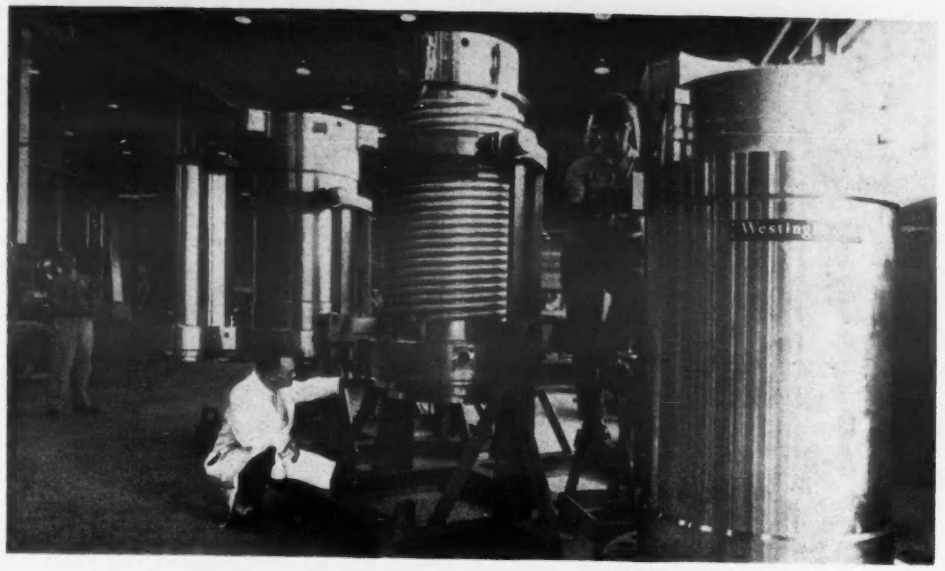


Fig. 4—Four "canned" motor-pumps, rated at 1600 h.p. and weighing 13 tons each, for installation at the Shippingport power station

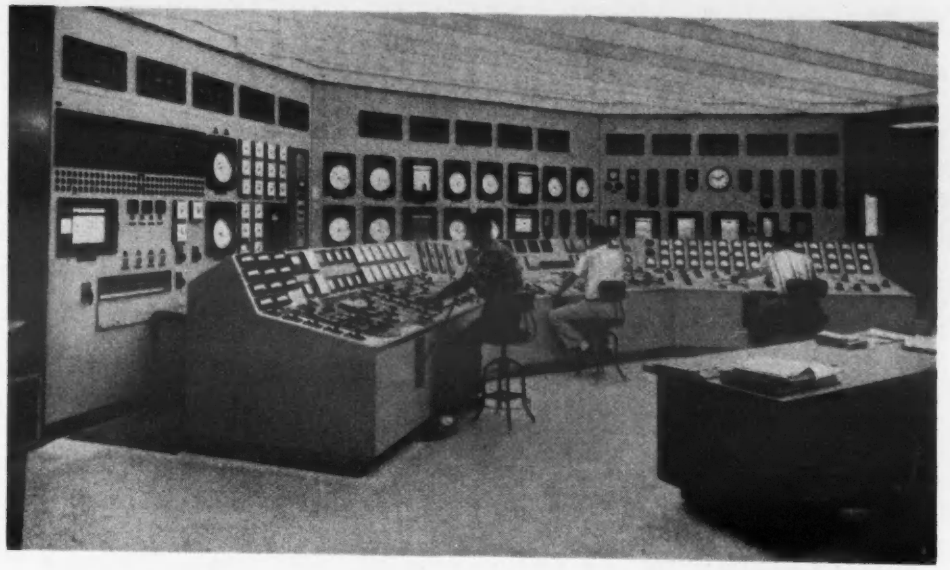


Fig. 5—Control room of the Shippingport power station, with controls for both the nuclear and the conventional portions of the plant

the inlet temperature, however, the higher the core cost. Increasing the inlet temperature gives lower steam-generator costs. By a series of design approximations, the most economical overall design parameters for the given set of conditions was obtained.

In general, the cost of equipment can be minimised by making the individual units larger and thus reducing the number required. There is, however, a competing factor in the increased mechanical complexity and fabrication difficulty associated with increased component size. The four loops selected result in units, such as primary coolant pumps, valves and piping, that are about as large as is practical with the present technology. The use of four loops gives the plant considerable operating flexibility because any one or even two loops can be shut down and even repaired without shutting down the remaining loops. The shielding between loops in the plant container makes this possible from a radiation standpoint.

One advantage of the design chosen is flexibility. This means that at any time, even after operation has begun, the core can be rearranged and the number of control rods changed to take advantage of knowledge gained in the critical experiment programme. It also may be desirable to rearrange the fuel sub-assemblies at various times during the core life to compensate for reactivity changes or to equalise fuel burn-up.

Great improvements probably can be made in the nuclear cores for this plant. To take advantage of this, the reactor vessel and the primary coolant system have been arranged to accommodate cores considerably larger than the first one and with flow and pressure drop requirements covering a broad range. It has already been shown that the first core will produce substantially more power than the 60MW minimum plant rating. It is also expected that sufficient information will be obtained from the operation and test of the present first core so that subsequent cores may produce sufficient heat energy to be compatible with the 100MW rating of the turbine generator. Due to lack of basic knowledge on pressurised water reactor plants, a considerable number of rather costly safety measures, such as the plant container, have been included. The experience gained in the operation of this plant will enable such measures to be evaluated and therefore possibly to be removed from future plants.

Component Design

To restrict the spread of radioactivity in the event of a dual casualty (i.e. rupture of the primary coolant system and subsequent melting of the nuclear core with attendant release of fission products) the nuclear part of the plant is enclosed completely inside a steel container. This container is sized to contain the pressure created by a rupture of the primary coolant system of the most adverse size, including the effect of the stored energy in the water and the metal as well as any conceivable energy release due to a zirconium-water reaction. The plant container is divided into four units connected by large tubular ducts. The reactor vessel is situated in the spherical section, and two of the main coolant loops are in each of the adjacent cylindrical sections. The fourth cylindrical section is connected into the other three and contains the auxiliary systems.

The reactor vessel (as shown in The Engineer, January 20, 1956, page 112) has an overall height of 33ft, with a cylindrical section with a nominal wall thickness of 8½in. The vessel was constructed at the Chattanooga works of Combustion Engineering, Incorporated, in Tennessee. It was designed to withstand a 2500 lb per square inch gauge internal pressure at 600 deg. Fah. At the rated load 26,000,000 lb of primary coolant water enters the vessel each hour through four inlet nozzles and passes through the core, where the temperature is raised from 507 deg. to 542 deg, Fah. The dry weight of the vessel is 235 tons, of which the shell portion weighs 150 tons and the removable top head 85 tons. In addition, the vessel contains thermal shields, a core assembly and other equipment having a total weight of an additional 100 tons. The internal diameter is 9ft 1in and the length from the inside of the lower head to the inside of the top head is 21ft 3in. The top head is fastened to the shell section by means of forty-two 6in diameter studs, each 80½in long. Each stud with its accompanying nuts weighs 700 lb. To secure the head to the vessel shell these studs are elongated by heat supplied from electric heaters extending into the centre of the studs so that the nuts can be turned through a predetermined angle to induce the required stud tension when the studs cool to ambient temperature. The stud tension required to maintain contact of the mating surfaces of the head and shell under design conditions is 40,000 lb per square inch. The removability of the head is a design requirement to facilitate the servicing of the interior of the vessel. Since the hot primary coolant water circulated through the reactor vessel is corrosive, the internal portions of the vessel are clad with a ¼in minimum thickness of a corrosion-resistant stainless steel. The hemispherical bottom head and shell courses were fabricated from manganese-molybdenum clad plate having 6in and 8¾in minimum thicknesses respectively. These integrally clad plates were fabricated by the Lukens Steel Company. The massive head hemispherical portions of the removable head could not be procured with the stainless steel integrally clad. In order to clad these thicker sections a special device for cladding the base metal by weld deposit was developed at the Chattanooga shops of the company. The base material of the vessel is manganese-molybdenum steel, meeting the requirements of the A.S.M.E. Material Specification SA-302, Grade B, which calls for a minimum tensile strength of 80,000 lb per square inch. The specified composition is manganese 1·10 to 1·50 per cent, molybdenum 0·40 to 0·60 per cent, and carbon 0·27 per cent. The stainless cladding is A.I.S.I. Type 304-L, 18 per cent chromium, 8 per cent nickel steel, with a maximum specified carbon of 0·03 per cent. The bond between the cladding and the base metal must be sufficient to meet the shear test requirements under A.S.M.E. Specification SA-264, and the continuity of bond was ensured by ultrasonic reflectoscope inspection of 100 per cent of the plate surfaces. Some idea of the problems regarding manufacturing of the reactor vessel can be gained by realising that the parts making up the vessel were the biggest and the heaviest of their kind ever made by the firm. The procurement of plate material presented one of the more difficult problems. This involved getting very thick and heavy clad plates with an integral bond between the clad and backing plate. The flanges for the vessel and heads presented difficult alloy-steel forging problems, which were finally solved by the Bethlehem Steel Company. After forming the parts, the mating edges were machined to provide welding grooves. All of the welding operations were required to be performed while the parts were kept hot, thus increasing the difficulties of fabrication. Welding of the thicknesses involved up to 10in required very close control of the welding technique. Radiographing of the welds joining the various parts was performed on a 15MeV betatron. The heat-treatment of all welds was done in large heat-treating furnaces at elevated temperatures to relieve the stresses in the material. On some parts the accumulated heat-treating time amounted to about sixty days. All clad surfaces were inspected with a dye penetrant fluid to ensure the absence of any minute flaws. All the backing plate surfaces were inspected with a magnetic particle test to ensure freedom of defects. The machining operation was performed using optical methods to align various matching machined surfaces.

The vessel is supported by the neutron shield tank at a point just below the vessel flange. This permits the vessel to grow due to thermal expansion with a minimum increase in main-loop piping stresses. The entire vessel is thermally insulated with about 4in of glass-wool insulation. The core assemblies are supported in a stainless-steel cage consisting of a barrel, a bottom plate and a support grid. The cage is nearly 8ft in outside diameter and slightly over 13ft high.

A pump in each of the loops circulates coolant. The pump utilises a single-winding motor of 1200kW capacity, which can be connected to run at two speeds. The motor weighs about 20,000 lb and is mounted in the cast stainless steel volute of the pump. Two hydraulically operated main stop valves are required in each loop. One of these valves is a parallel-disc gate valve, hermetically sealed and provided with an integral cylinder and piston method of operation. Latches hold it in the closed position. The nominal size of the valve opening is 16in with ports tapered to an 18in pipe size. The valve is designed for normal operation at differential pressures of 600 lb to 1000 lb per square inch across the piston, but can withstand stresses resulting from emergency application of a 3000 lb per square inch differential pressure. This valve will shut off against a maximum differential gate pressure of 600 lb per square inch, although the normal shut-off pressure is a maximum of 210 lb per square inch absolute. Position indicators show when the valve is fully open or fully closed. Eight manual valves serve as stand-by units for the hydraulically-operated stop valves.

The steam generators are each rated at 263×10^6 B.Tn.U. per hour and provide 600 lb per square inch absolute full-power steam pressure ; this pressure rises to 885 lb per square inch absolute at no load. The secondary-side design pressure is 975 lb per square inch absolute. The primary-side operating pressure is 2000 lb per square inch, with a design pressure of 2500 lb per square inch. Each loop has 16,800 gallons per minute of primary cooling water passing through the tubes, entering at a temperature of 542 deg. Fah. and leaving at 508 deg. Fah. Two of the steam generators are entirely of stainless steel and are of a straight tube, fixed tube sheet design. They are 36ft long and 43in in diameter. The other two units are of a return bend or U-tube design. The overall length is 28ft, and the diameter is 39in. Steam generators of the two different designs are used so that experience can be gained in the design, manufacture and operation of both types to provide more knowledge on which to base the design of future plants.

The pressurising tank is 18ft high and 5ft in inside diameter, with a total volume of 300 cubic feet, of which about 150 cubic feet is the steam dome volume with maximum water level. Normal surges may be as great as plus or minus 10 cubic feet under design plant load fluctuations. Under these design conditions the primary system pressures will be held within limits of 1850 lb to 2185 lb per square inch absolute. A 6in surge line in the bottom head connects this tank with the primary coolant system.

The heater section contains 200 heater wells, into which are inserted replaceable electric heaters of 500kW capacity. These are arranged electrically into three groups and are controlled to maintain a saturation temperature of 636 deg. Fah. corresponding to a pressure of 2000 lb per square inch absolute and to form a steam bubble in the top of the tank. A spray nozzle at the top sprays colder water into the steam during positive surges to help limit the maximum pressures. Situated in the centre of the tank is a standpipe for use as a reference leg for water-level measurement. A low-level alarm warns the operator to add water to the system before the level drops to a point where negative surges could uncover the heater wells.

(*To be continued*)

United States Steel Corporation

The fifty-sixth annual report of the United States Steel Corporation, published on March 19, shows that the Corporation's production of steel ingots and castings was 33,700,000 tons, or slightly more than in 1956 ; the shipment of steel products was 23,400,000 tons in 1957, compared with 23,900,000 tons in 1956, the trend being steadily downwards. The income for 1957 was 419·4 million dollars, or 9·5 per cent on sales, compared with 348·1 million dollars, or 8·2 per cent on sales in 1956. The Corporation's research and development activities include a programme of 1002 specific projects. As an example, towards the end of the year, successful experimental rollings were made of stainless and alloy steels by the so-called "sandwich process," whereby the feasibility of producing sheets up to 90in wide, 230in long and 0·033in thick, has been demonstrated.

Personal and Business

Appointments

MR. H. S. BUTT has been appointed production director of Dowty Equipment, Ltd.

SIGMUND PUMPS, Ltd., has announced that Mr. H. P. Lord has been appointed general sales manager.

MR. WILFRID BAILEY has been appointed secretary to the Gas Council in succession to Mr. F. G. Brewer, who is to retire at the end of September.

MR. D. W. STANDISH has been appointed sales engineer in the Yorkshire district of the Berry Hill Plant Division of Berry Hill (Engineers), Ltd.

MR. G. C. HAYNES has been appointed deputy managing director of Boulton Paul Aircraft, Ltd., and Mr. G. A. Woolsey has been appointed secretary.

MR. L. F. MILLER, deputy chief contracts officer of the Central Electricity Generating Board, has been appointed chief purchasing and contracts officer of the Board.

MR. E. C. WESTON has been appointed general manager of Flexibox, Ltd., and Mr. J. Babington Smith has been placed in charge of the company's London office.

MR. T. P. ROME, A.M.I.E.E., has been appointed Liverpool branch manager of British Insulated Callender's Cables, Ltd., following the voluntary retirement of Mr. L. J. Fairhurst.

MR. F. S. MITMAN has been appointed a director of Rubery, Owen and Co., Ltd., the parent firm in the Owen organisation. He is relinquishing his directorships in several of the subsidiary companies.

MR. A. W. PAGE has been appointed sales manager of Igranic Electric Company, Ltd., in succession to Mr. R. L. Paice, who has relinquished the position. Mr. Paice remains a director of the company and will carry out special assignments.

THE BRITISH TRANSPORT COMMISSION has nominated Mr. David Blee, Mr. F. Grundy, Mr. J. P. Young and Mr. H. L. Hopkins to the Coastal Shipping Advisory Committee. The Minister of Transport and Civil Aviation has been informed of these nominations.

WILLIAM DOXFORD AND SONS (ENGINEERS), Ltd., has announced that Mr. Arthur Storey has resigned his position as director and managing director, and that until other arrangements have been made Dr. J. Ramsay Gebbie has agreed to act as managing director of the company.

SIR NORMAN KIPPING, director-general of the Federation of British Industries, has been elected chairman of British Overseas Fairs, Ltd., in succession to Mr. Leslie Gamage, who has resigned the position. Mr. Gamage remains a director. Mr. W. P. N. Edwards has been appointed managing director.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION has announced the appointment of Mr. J. B. Veal to the new post of deputy director-general of navigational services, to assist the present director-general, Air-Commodore W. E. G. Mann. Mr. Veal has been succeeded as director of civil aviation safety and licensing by Mr. W. E. B. Griffiths.

Business Announcements

PLOWRIGHT BROTHERS, Ltd., Chesterfield, states that plans have been approved for the erection of new offices on a site on the Old Brampton Road.

THE METAL INDUSTRIES GROUP announces that it is acquiring, as from April 1, the whole of the share capital of the privately owned Farmer Brothers (Shifnal), Ltd.

LEVERTON OF LEEDS, Ltd., states that it has transferred its entire business from its former premises at Stanningley to its newly-erected premises at Gelderd Road, Gildersome, Leeds (telephone, Morley 4221).

ENFIELD CABLES, Ltd., has announced the signing of an agreement with Federal Wire and Cable Division, H. K. Porter Company (Canada), Ltd., whereby that organisation will market Enfield products in Canada.

MIDLAND SILICONES, Ltd., states that the distribution of silicone electrical insulating compound "MS4" throughout Scotland is to be handled by R. D. Taylor and Co., Ltd., 9, Lynedock Street, Glasgow, C.2.

THE CHAMBERLAIN GROUP OF COMPANIES states that the plant sale and hire activities of Chamberlain Industries, Ltd. Staffa Works, Staffa Road, Leyton, E.10, is to be transferred to a new company, Chamberlain Plant, Ltd., Crown Works, Southbury Road, Enfield, Middlesex.

BASTIAN AND ALLEN, Ltd., states that its Midland Counties area office has moved from Steelhouse Lane, to 71, Broad Street, Birmingham, 15 (telephone, Midland 7995). The Yorkshire and Lincoln area office has moved from Basinghall Street, Leeds, to 22, Ullswater Road, Bennett Lane, Dewsbury, Yorkshire.

THE EXPORT CREDITS GUARANTEE DEPARTMENT announces that its office in the City of London has moved to larger premises at Marlon House, Mark Lane, E.C.3 (telephone, Royal 3491). The Nottingham office of the department is to move to new premises at Lloyd's Bank Chambers, Old Market Square, Nottingham (telephone, Nottingham 46585), on March 25.

Contracts

LONDON TRANSPORT announces the placing of a contract for overhead cranes in the new strip-and-clean shop at Chiswick Works with Geo. W. King, Ltd., Argyle Works, Stevenage, Herts. The value of the contract is more than £11,000.

REDHEUGH IRON AND STEEL COMPANY, Ltd., has received a contract worth £400,000 from the Central Electricity Generating Authority for the supply of tunnel linings for the hydro-electric scheme at Ffestiniog, North Wales. The pipes will go into tunnels which are to be driven through the mountain side to carry water from the Stwlan reservoir to a generating station at a lower level.

C. A. PARSONS AND CO., Ltd., has been notified by the Central Electricity Generating Board of the Board's intention of placing an order with the company for a 550MW turbo-generator, condensing and feed heating plant. The machine is believed to be the largest to be ordered in the world ; it is for the projected Thorpe Marsh power station in Yorkshire. Operating steam conditions are 2300 lb per square inch pressure, 1050 deg. Fah. temperature with reheating to 1050 deg. Fah. The value of the contract will be about £5,000,000.

THE CEMENTATION COMPANY, Ltd., has been awarded a contract by the Administration of the Imperial Estates of Iran for the first bridge to be built across the River Karun to connect Khorramshahr, Iran's largest sea port, with the island and town of Abadan. The contract includes design and construction, at an approximate cost of £850,000. The waterway is 827ft wide and the bridge will consist of four spans, each of 162ft, and a central navigation span of 179ft. Headroom above the highest recorded flood level will be 22ft 6in, which will entail approach ramps of a total length of about 1200ft, carrying a dual roadway across the riverside boulevards. The width of the reinforced concrete roadway will be 24ft, with two 5ft footpaths. Financial support for the scheme is given by the Iranian Ministry of Customs, which will now go ahead with its plans to relieve congestion at the Port of Khorramshahr by the construction of additional berths at Khosro Abbad on Abadan Island.

Miscellanea

INJECTION MOULD HEATING.—An injection mould heating equipment is now being made by B.I.P. Tools, Ltd., 147, Tyburn Road, Birmingham, 24, for convenient attachment to any injection mould. This portable water heating unit is used to develop the desired mould temperature prior to moulding and it obviates the practice of mould heating by a preliminary run of scrap "shots" on a machine. It will maintain temperature on a mould which dissipates heat faster than the plastic charge can provide it.

PNEUMATIC BENCH VICE.—A safety cover, totally enclosing the distance travelled by the moving jaw, has been incorporated in the pneumatic bench vice made by the Consolidated Pneumatic Tool Company, of 232, Dawes Road, London, S.W.6. This vice has a 4in diameter air cylinder which gives 1000 lb thrust when operating on an 80 lb per square inch line pressure. The stroke of the piston and the moving jaw, which it actuates, is 1in, whilst the rear vice jaw is adjustable by means of a locating nut to allow work from $\frac{1}{4}$in to 5in in size to be accommodated. The vice jaw size is $3\frac{1}{2}$in by $4\frac{1}{2}$in.

NAVAL ARCHITECTURE SUMMER SCHOOL.—The Joint Committee for the Award of National Certificates in Naval Architecture, on which the Institution of Naval Architects is represented together with the Worshipful Company of Shipwrights and the Ministry of Education, is collaborating with the Ministry in the organisation of a summer school for teachers of naval architecture, which is to be held at the College of Aeronautics, Cranfield, from July 20 to 25 inclusive. There are to be lectures given by specialists in various branches of naval architecture and allied subjects. Applications to attend should be made, through the principal of the technical college concerned, to the Ministry of Education not later than April 19, 1958.

MECHANICAL ENGINEERING RESEARCH LABORATORY.—There are to be "open days" at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, on Wednesday and Thursday, June 4 and 5. Representatives of any organisation with engineering interests will be welcome. Applications for invitations, stating which day is preferred, should be sent to the director. The whole of the establishment will be open for inspection, including two new laboratories for research on mechanisms and engineering metrology, and for research on heat transfer.

SHORT WHEELBASE EIGHT-WHEELER.—A version of the Albion "Caledonian" intended for use with an end tipping body has now been introduced ; it has a wheelbase of 14ft 9in instead of the 17ft 6in of haulage vehicles, and, assuming $2\frac{1}{2}$ tons of body, tipping gear and equipment, disposes of $15\frac{1}{2}$ tons load. The vehicles are powered by the Leyland O.600 engine of 125 h.p., but differ from the "Octopus" in having brakes on both front axles and separate springs for each rear axle with balance beams. The brakes are hydraulic with air assistance instead of air operated.

DIE SET SELECTION CHARTS.—A series of printed full-scale outline drawings covering the range of the firm's most commonly used standardised die sets has been produced by Desoutter Bros., Ltd., The Hyde, Hendon, London, N.W.9, to speed up drawing production in jig and tool drawing-offices. With these charts available, a draughtsman, after completing a press tool drawing, has merely to select the most suitable die set shape, position it under the drawing and trace off. Alternatively, the die set shape may be traced first and the press tool design drawn within the shape. On each chart there are given the leading specification details of the set, together with a list of die spaces available in that particular die set range. The drawings now available cover most sets with die spaces up to $5\frac{1}{2}$in diameter, for circular types ; 8in and $3\frac{1}{2}$in and $6\frac{1}{2}$in and $5\frac{1}{2}$in for rectangular and 7in by 5in for square designs.

AIR-CONDITIONED FACTORY BLOCK.—A multi-storey factory block, which is air conditioned and temperature controlled, has recently been added to R. B. Pullin and Co., Ltd.'s Phœnix Works at Brentford. This building has been designed to suit the company's gyroscopic, electrical and electronic precision instrument production. The whole of the air circulation ducts are within a reinforced-concrete hollow-column frame and are not visible either inside or outside the building. An unusual feature of design is the ring main electrical busbar system, whereby 500kW copper busbars are carried up two vertical service ducts—one at each end of the building. These are linked at each floor level by horizontal busbars carried within suspended ceilings over central circulating corridors. Each section can be isolated and controlled by main switchgear housed in the vertical ducts. These ducts also carry heating, gas, water, air lines and high- and low-voltage electricity supplies, and thus the building interior is free from dust-collecting pipes and ledges. The importance of the highest standard of general lighting has been recognised by installing a system of "graded" artificial lighting to ensure even illumination under varying conditions. The building has a working area of some 70,000 square feet, comprising lower and upper ground floors and a further four floors all served by automatic combined passenger/goods and goods lifts.

POINT BLOCKS OF FLATS IN SHEFFIELD.—We have drawn attention in these columns on several occasions to the increasing popularity of "point blocks" of flats, with heights of ten storeys or more, and particularly to the structural engineering aspects of this type of construction. Construction has recently started of the first scheme of this kind in Sheffield, where ten thirteen-storey blocks, containing 480 flats, are to be built. The structural design of these blocks is based upon *in situ* reinforced concrete, and it is claimed that the design has been evolved to achieve the utmost economy. The columns of the structural frame are carried down to a spread foundation on sandstone or shale, and they are connected by floor slabs 5in thick, which span the actual areas of individual flats without internal beams, thus allowing an economy in storey height. The structure incorporates two staircases, with a common landing at each floor, and two lifts serving alternate floors. The walls of the lift shafts are of *in situ* concrete and have a structural function. All cables and pipes are carried in large internal ducts at the back of each lift shaft. Repetition of structural elements and their detailing is considered to have been an important factor in the economy of the design. The contract period for the scheme is eighty-four weeks, and the price £1,030,000. The Sheffield city architect is Mr. J. L. Womersley, who developed the scheme in conjunction with the consulting engineers, John Liversedge and Associates. The main contractor is Tersons, Ltd.

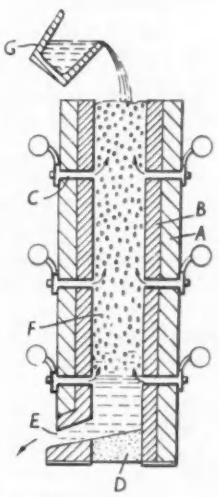
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings Chancery Lane, W.C.2, 3s. 6d. each.

METALLURGY

790,790. June 2, 1955.—THE REFINING OF IMPURE IRON, The British Oxygen Company, Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1. (*Inventors: Leonard Charles Bannister, William John Badenock Chater and James Anthony Charles.*)

The invention relates to the refining of impure iron and more particularly to the removal of impurities such as sulphur, phosphorus, manganese and silicon from molten iron as a step in the formation of steel. According to the present invention, a process for reducing the impurity content of iron comprises passing the molten iron down through a tower containing incombustible packing material, pre-heated to a temperature such that the molten metal does not freeze during its passage through the tower, in countercurrent flow to a stream of an oxidising gas in such manner that an oxidising zone is produced at the bottom of the tower and a reducing zone at the top. The incombustible packing material may be a material which will assist in the impurity removal, for example, limestone or lime. Alternatively, it may consist of inert refractory material. The term "oxidising gas" as used is intended to cover pure oxygen, air, oxygen-enriched air, oxygen in admixture with carbon dioxide or steam or any other oxygen-containing gas (or admixture of these gases), the oxygen content of which, together with oxygen available from any of the fluxing materials, is sufficient to achieve the desired impurity oxidation. It is not intended to cover a gas mixture including a constituent, such as a fuel gas, which will react with the oxygen present during passage of the gas mixture through the tower. A suitable form of tower for use in the process of the invention is shown in cross-section in the drawing. The tower *A* is made of insulating brick and is provided with a lining *B* of a suitable refractory material, such as dolomite, silica, chromite, magnesite, alumina or sillimanite. Tuyeres *C* for the introduction of the oxidising gas are provided at three levels up the tower and, if desired, may be provided with appropriate cooling means. Alternatively, the tuyeres may be on more or less levels than three or else all at the bottom of the tower. In the form of tower illustrated, the tuyeres *C* are shown as horizontal but, if desired, their direction may be varied, so as to achieve control of the oxidation reaction. At the bottom of the tower is located a renewable hearth *D* sloping to an exit *E* for the treated metal and slag. The tower is filled with a bed *F* of packing material. In operation, the tower is initially heated by any appropriate method. The empty tower may be charged with coke or like solid fuel to about one-third full and brought to a bright-red heat by passage of oxygen or oxygen-containing gas through the tuyeres. Mixtures of limestone and coke, or lime-coated coke, are subsequently added until the tower is full and combustion is continued until all the coke has burnt away. Molten metal is then poured into the tower from a ladle (indicated at *G*). The height of the bed *F* is maintained during passage of the molten metal by further additions of limestone. As previously stated, one or more fluxing materials and/or slag may be charged together with the limestone while filling the tower and added as the bed falls during operation. The final metal product and the slag formed collect on the hearth *D* and are discharged simultaneously through the exit *E* to a fore-hearth where they are separated. The slag may then be recycled, if desired, to the top of the tower. Alternatively, the tower may be so constructed that the metal product and slag are retained on the hearth, tappings at two levels being made for the separation of metal from slag.—*February* 19, 1958.



No. 790,790

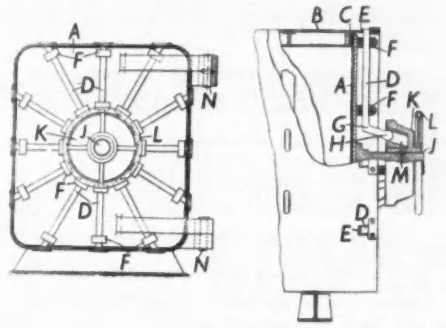
791,354. December 23, 1955.—PROCESS FOR THE HEAT TREATMENT OF STEEL, The Bochumer Verein für Gussstahlfabrikation Aktiengesellschaft, formerly Gussstahlwerk Bochumer Verein Aktiengesellschaft, of Bochum, Germany.

According to the invention, there is provided a process for heat treating steel, wherein elongated pieces such as steel bars, plate slabs or billets, are heated for a very short time, preferably twenty to eighty seconds, to a temperature in the range between 500 deg. and 1200 deg. Cent. by an electric current which is passed through the length of the pieces. The steel pieces, if necessary, after intermediate cooling to a temperature of 650 deg. Cent. or less, then being introduced into a furnace for a heat treatment process of long duration, such as soft annealing, isothermal transformation annealing or homogenising. Steels which are difficult to deal with as regards solubility of structural components may be brought by the heating for a very short time to a temperature of over 1000 deg. Cent. and thereafter quenched to a temperature of 650 deg. Cent. or less. After the heating for a very short time the steels are brought immediately by means of a charging apparatus into a suitably hot furnace where the particular desired further treatment of the kind mentioned is carried out. By the invention, the temperature at the periphery of a piece no longer rises more rapidly than in the interior of the steel piece. On the contrary, in the temperature range relevant to these solid solubility phenomena, the temperature in the interior of a piece is in advance of the outside temperature if the relationship of the current intensity to the cross-section of a piece is suitably chosen. It is easy to determine the high current intensities to be used in each individual case, having regard to the particular cross-section in question. Examples are also given in the specification.—*February* 26, 1958.

PRESSURE VESSELS

791,086. April 22, 1955.—DOORS FOR PRESSURE VESSELS, Foster, Yates and Thom, Ltd., Blackburn, Lancashire, and Allen and Hanbury's, Ltd., 48, Wigmore Street, London, W.1. (*Inventor: Norman Wayland Loudsley.*)

The invention relates to doors for pressure vessels such as autoclaves, sterilisers, vacuum chambers and the like, and has for its object to provide an improved method of locking. As the drawing shows, the door *A* fits into the front end of the pressure vessel *B* and is held against a sealing ring *C* by bolts *D* which enter slots *E* in the wall of the vessel. The bolts *D* are slidable radially in bearings *F* on the door. The



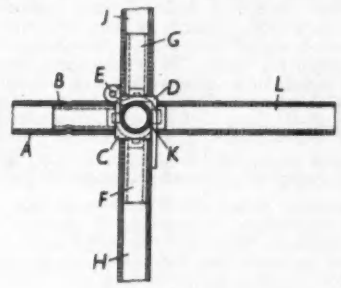
No. 791,086

inner end *G* of each bolt is bent away from the door to make an obtuse angle with the radial part, the extremity being enlarged to form a ball *H*. A threaded spindle *J* is fixed to the centre of the door, and a sheath member *K* with a hand wheel *L* attached to it is threaded on to the spindle. The sheath has a conical annular slot *M*, the cone angle being equal to the angle at which the end parts *G* of the bolts are bent. The slot *M* is open towards the door and is wide enough to take the enlarged ends *H* of the bolts. The door swings on hinges *N*. As the sheath member *K* moves axially along the spindle when the hand wheel is turned, the slot *M* slides over the ends *H* of the bolts, and pulls the bolts inwards to the unlocked position as it approaches the door, and vice versa.—*February* 26, 1958.

STEEL SCAFFOLDING

791,110. November 20, 1956.—TUBULAR SCAFFOLDING, Rohren-und Roheisen-Grosshandel G.m.b.H., 18, Neue Mainzerstrasse, Frankfurt/Main, Germany. (*Inventor: Peter Liesenfeld.*)

The invention relates to tubular scaffolding and is particularly concerned with a connecting element for such scaffolding. As shown in the drawing, a tube *A* has fixed at each end tube sections *B*. The tubular sections *B* are welded to a fixed half-shell *C*, a movable half-shell *D* being pivoted thereon by means of a pin *E*. Rigidly connected to the half-shell *C* is a tubular spigot *F* and a tubular spigot *G* is similarly connected to the half-shell *D*, the external diameter of the spigot *G* being of such a size that it can be fitted in the end of a vertical tube *H* or *J* of the tubular scaffolding. The tube clamp formed by the half-shells *C* and *D* is of such a size that it can accom-



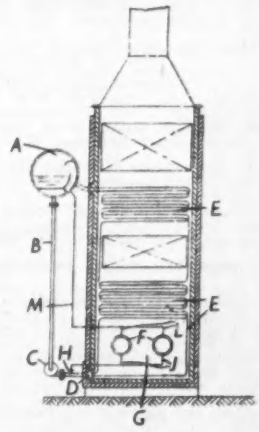
No. 791,110

modate and clamp a horizontal longitudinal scaffold tube *K*. The pivoted half-shell *D* also carries a tubular extension *L*, the length of which can be about 30cm, and consequently is generally considerably larger than the spigots *F* and *G*. The element is used in the following manner: after a pair of tubes *H* have been set up vertically, the attachments or spigots *F* are inserted from above into the tubes, so that they are connected to one another by the tube *A*. Longitudinal tubes *K* are then laid in the half-shells *C*, and the pivoted half-shells are then swung in such manner that the tubes *K* are clamped between the half-shells, as shown. Vertical tubes *J* are now fitted on the spigot *G*. Owing to the loading pressure which is exerted by the tubes positioned on the spigot, the longitudinal tubes *K* can be reliably clamped between the half-shells. The tubes *J* may then have another tube *A* positioned thereon by the spigots *F* being inserted therein. The tubes *A* serve to carry the platform or scaffold boards. The extensions *L* serve as brackets or cantilevers which can also be used to support scaffold boards. The arrangement according to the invention has the advantage that the scaffold can be erected in a much shorter time, that no detachable parts are provided, and that the load on the vertical tubes is always central.—*February* 26, 1958.

STEAM GENERATORS

790,853. December 14, 1954.—LIQUID FUEL FIRED COMBUSTION APPARATUS, La Mont International Association, Ltd., 42, Leicester Square, London, W.C.2. (*Inventor: Karl Hans Reppel.*)

The invention relates to the application of combustion apparatus for liquid fuel firing, particularly as applied to steam generators, gas turbines and like plant. The object of the invention is to improve the combustion, reduce the space required by the combustion apparatus and extend the life of such apparatus. The drawing shows the application of the liquid fuel fired combustion apparatus to a boiler of the forced recirculation type. Boiler water from the steam and water drum *A* circulates via the suction pipe *B*, circulating pump *C*, distributor header *D*, and the evaporating tubes *E*, back to the drum.



No. 790,853

Two liquid fuel fired combustion units comprising chambers *F* are arranged in the chamber *G*. Their walls are cooled by a portion of the boiler water in circulation, the cooling water being branched off at *H*. The cooling water flows through pipes *J* and subsequently passes through the helically wound tubes forming the walls of the combustion chambers *F*, from where it is led through pipes *L* and *M* back to the drum. The specification also shows the application of the combustion apparatus to a gas turbine, to which an exhaust gas boiler of the forced recirculation type is fitted.—*February* 19, 1958.

Launches and Trial Trips

SUNGATE, cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Turnbull Scott Shipping Company, Ltd.; length between perpendiculars 435ft, breadth moulded 59ft 9in, depth moulded to shelter deck 39ft 3in, deadweight 10,800 tons, speed 13½ knots; five holds, one 25-ton, four 10-ton and six 5-ton derricks, electric deck machinery; three 175kW and one 30kW diesel-driven generators; Hawthorn-Doxford opposed-piston, two-cycle oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, 4400 b.h.p. at 115 r.p.m., arranged to burn heavy fuel. Launch, November 9.

ARGOBEAM, closed shelter deck cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Argobeam Shipping Company, Ltd.; length between perpendiculars 445ft 10in, breadth moulded 62ft 4¾in, depth moulded to upper deck 41ft, deadweight 13,670 tons; five cargo holds, ten 10-ton derricks; electric deck machinery, three 180kW diesel-driven generators; Kincaid-B. and W. two-cycle, single-acting, pressure-charged diesel engine, six cylinders, 620mm diameter by 1400mm stroke, 5800 b.h.p. at 118 r.p.m.; arranged to burn heavy fuel. Trial, November 12.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Wed., March 26.—BRIGHTON, HOVE AND DISTRICT BRANCH: New Imperial Hotel, First Avenue, Hove, "Automation," I. McNeill, 7.30 p.m. ★ NOTTINGHAM BRANCH: East Midlands Electricity Board's Showroom Theatre, Smithy Row, Nottingham. "Using Electricity to Reduce Concrete Setting Time," H. Twemlow, 7.30 p.m.

Thurs., March 27.—SOUTH LONDON BRANCH: Greyhound Hotel, High Street, Croydon, "The Safe Use of Electricity," S. J. Emerson, 8 p.m.

Fri., March 28.—COVENTRY BRANCH: Craven Arms, Coventry, Films, "Electronics" and "Electronics in Industry," 8.15 p.m.

Sat., March 29.—NORTH LONDON BRANCH: Visit to the National Physical Laboratory, Teddington, 2 p.m. ★ YORK BRANCH: Visit to the English Electric Company, Ltd., Bradford Works, 10 a.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, March 21.—MERSEYSIDE SECTION: Technical College, Birkenhead, "Radio Exploration of the Galaxy," J. E. Baldwin, 7 p.m.

Wed., March 26.—LONDON BRANCH: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Electronics in Medicine," R. F. Farr, 6.30 p.m. ★ SOUTH WALES BRANCH: Department of Physics, University College of South Wales, Cardiff, "Television Lighting Effects," A. E. Robertson, 6.30 p.m. ★ NORTH WESTERN BRANCH: Reynolds Hall, College of Technology, Sackville Street, Manchester, 1, "Electronic Handling Technique," R. N. Settle, 6.30 p.m.

Fri., March 28.—SOUTH MIDLANDS BRANCH: Winter Gardens, Malvern, "Transistors in Reception," L. E. Jansson, 7 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., March 26.—MIDLAND REGION: Birmingham Exchange and Engineering Centre, Birmingham, "Feedwater Systems and Ancillary Equipment," C. G. Scolding, 10.30 a.m.; "The Effect of Coal Characteristics on the Operation of Mechanical Stokers," G. G. Thurlow, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 24.—LEEDS CENTRE: Lighting Service Bureau, 24, Aire Street, Leeds, 1, "Street Lighting in Leeds and Remote Control Systems," K. J. Goddard and T. C. Holdsworth, 6.15 p.m. ★ LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "Television Studio Lighting Equipment," K. R. Ackerman, 7 p.m.

Tues., March 25.—LEEDS CENTRE: Yorkshire Electricity Board, Ferensway, Hull, Annual General Meeting of Hull Section, 6.30 p.m.

Fri., March 28.—BIRMINGHAM CENTRE: Regent House, St. Phillip's Place, Colmore Row, Birmingham, "Lighting in Relation to Modern Ceilings and Roofs," D. Phillips, 6 p.m.

INCORPORATED PLANT ENGINEERS

To-day, March 21.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, Annual General Meeting, 7.30 p.m.

Tues., March 25.—WESTERN BRANCH: Grand Hotel, Bristol, Annual General Meeting, 7.15 p.m.

Thurs., March 27.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, Annual General Meeting, Films, 7.30 p.m.

Mon., March 31.—WEST AND EAST YORKSHIRE BRANCH: The University, Leeds, Annual General Meeting, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., March 26.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, "Patternmaking Progress," B. Levy, 7.30 p.m.

INSTITUTE OF FUEL

Wed., March 26.—LONDON SECTION: Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, "The Dewatering of Fine Coal," V. R. Gray, 5.30 p.m. ★ YORKSHIRE SECTION: Royal Victoria Hotel, Sheffield, Annual General Meeting, 2.30 p.m.

Thurs., March 27.—MERSEYSIDE SUB-SECTION: Liverpool Engineering Society's Rooms, 9, The Temple, Dale Street, Liverpool, "Process Steam," L. G. Northcroft, Annual General Meeting, 7 p.m. ★ MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Reactor Operation and Fuel Element Processing at Windscale Works," T. Tuohy, 6.30 p.m. ★ SCOTTISH SECTION: Royal College of Science and Technology, Glasgow, Annual General Meeting; "Domestic Heating Appliances," R. H. Rouse, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Thurs., March 27.—LLOYD'S REGISTER LECTURE FOR STUDENTS: Memorial Building, 76, Mark Lane, London, E.C.3, "The Free Piston Engine," P. A. Watson, 5.30 p.m.

INSTITUTE OF NAVIGATION

To-day, March 21.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The Effective Utilization of Airspace," E. J. Dickie, 5.15 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 25.—LONDON BRANCH: Great George Street, Westminster, London, S.W.1, "Flow in Alluvial Channels with Sandy Mobile Beds," G. Lacey, 5.30 p.m.

Fri., March 28.—NORTH WESTERN BRANCH: 9, The Temple, 24, Dale Street, Liverpool, "Foundation Problems in the North Western Area," J. K. Alderman, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., March 24.—NORTH EASTERN CENTRE: Neville Hall, Newcastle upon Tyne, "The Design of a 330kV Transmission System for Rhodesia," F. C. Winfield, T. W. Wilcox and G. Lyon, 6.15 p.m. ★ SOUTH MIDLAND RADIO AND MEASUREMENTS GROUP: James Watt Memorial Institute, Great Charles Street, Birmingham, "Colour Television," D. A. Maurice, 6 p.m. ★ WESTERN UTILIZATION GROUP: Technical College, Bath, "Brushless Variable-Speed Induction Motors," F. C. Williams and E. R. Laithwaite, 6 p.m.

Tues., March 25.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "The Atomic Clock," L. Essen, 5.30 p.m. ★ EAST MIDLAND CENTRE: College of Arts and Crafts, Nottingham, "Some Practical Considerations of Mine Electrification," G. Rutter, 6.30 p.m. ★ CAMBRIDGE RADIO AND TELECOMMUNICATION GROUP: University Arms Hotel, Cambridge, "Domestic High-Fidelity Reproduction," J. Moir, 8 p.m. ★ NORTH MIDLAND CENTRE: C.E.A., Yorkshire Division, 1, Whitehall Road, Leeds, Discussion on "The Teaching of Electricity Supply," opened by G. Shepherd, 6.30 p.m. ★ NORTH WESTERN MEASUREMENT AND CONTROL GROUP: Engineers' Club, 17, Albert Square, Manchester, "Meters and Meter Engineers," H. S. Petch, 6.15 p.m.

Wed., March 26.—SUPPLY SECTION: Savoy Place, London, W.C.2, "The Objective for Euratom," F. Giordani, 5.30 p.m. ★ SOUTHERN CENTRE: S.E.B. Offices, Cosham, Portsmouth, Joint Meeting with Southern Graduate and Student Sections, "System Control of the Electricity Grid," J. Williamson, 6.30 p.m.

Thurs., March 27.—LONDON GRADUATE AND STUDENT SECTION: Medway College of Technology, Chatham, Kent, "The Application of Nuclear Energy to Power Production," T. R. Puzey, 7 p.m. ★ EAST MIDLAND CENTRE: Demonstration Room, E.M.E.B., Spalding, "Electrical Energy from the Wind," E. W. Golding, 7.30 p.m. ★ SCOTTISH CENTRE: Royal College of Science and Technology, George Street, Glasgow, C.1, "The Electrification of the British Railways," by the late G. H. Fletcher, to be read by R. Ledger, 7.30 p.m. ★ HATFIELD DISTRICT BRANCH: Technical College, Hatfield, "Electrical Synthesis of Music," A. Douglas, 7 p.m.

Thurs. and Fri., March 27 *and* 28.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, Convention on "Radio Aids to Aeronautical and Marine Navigation," 2.30 p.m.

Mon., March 31.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Future Radiocommunication Methods for Civil Aircraft," W. E. Brunt, 5.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Royal Institution, Colquitt Street, Liverpool, Annual General Meeting; "Colour Television," L. C. Jesty and E. L. C. White, 6.30 p.m. ★ NORTH EASTERN RADIO AND MEASUREMENTS GROUP: Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, Annual General Meeting, 6.15 p.m. ★ SOUTH MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, Joint Meeting with Supply and Utilization Group, "Electrical Floor Warming," J. W. Moule and W. M. Stevenson, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Sat., March 29.—NORTH EAST BRANCH: Visit to B.B.C. Television Transmitting Station, Pontop Pike, 2 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., April 1.—39, Elmbank Crescent, Glasgow, C.1, "Provision of Ore Handling Facilities at General Terminus Quay, Glasgow," A. Young and G. Gray, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Tues., April 1.—EAST ANGLIA BRANCH: Assembly House, Norwich, Annual General Meeting, Films, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 21.—ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, "Failure of a 60MW Steam Turbo-Generator at Uskmouth Power Station," A. L. G. Lindley and F. H. S. Brown, 6 p.m. ★ BARROW-IN-FURNESS PANEL: Danson's Café, St. George's Terrace, Millom, "Pressurised Gas Systems for Reactors," G. Brown, 7.30 p.m.

Tues., March 25.—EASTERN BRANCH: Red Lion Hotel, Colchester, "The Steam Catapult," C. C. Mitchell and Q. H. Paterson, 7.30 p.m. ★ BIRMINGHAM A.D. CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "Test Bed Installations and Engine Test Equipment," H. G. Freeston, and "Type Testing," R. A. Laurence, 6.30 p.m. ★ WESTERN GRADUATES' SECTION: Bristol University Engineering Laboratories, University Walk, Bristol, 8, Annual General Meeting; Films, 7.15 p.m.

Tues. to Thurs., March 25 *to* 27.—1, Birdcage Walk, Westminster, London, S.W.1, Conference on "Technology of Engineering Manufacture," 10 a.m. to 12.45 p.m. and 2.30 p.m. to 5 p.m.

Wed., March 26.—SOUTHERN BRANCH: Visit to Edwards' High Vacuum, Ltd., Manor Royal, Crawley, 2.45 p.m.; "Quality Engineering," F. Dixon, 6 p.m. ★ YORKSHIRE BRANCH: The University, St. George's Square, Sheffield, "A Review of Applications of Radioisotopes in Engineering," D. B. Smith, 6.30 p.m. ★ SOUTHERN GRADUATES' SECTION: Technical College, Southampton, "The Application of Electronics to Engineering," R. J. Miles, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION: Visit to M.G. Cars, Ltd., Abingdon, 2.30 p.m.

Thurs., March 27.—NORTH WESTERN INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: Engineers' Club, Albert Square, Manchester, "The Commissioning and Maintenance of Plant at Atomic Energy Factories," G. D. Ireland, 6.45 p.m. ★ WESTERN A.D. CENTRE: Royal Hotel, Bristol, "The Turbo-Charging of High-Speed Diesel Engines: Present Position and Future Prospects," C. H. Bradbury, 6.45 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: Technical College, Lincoln, Films, 7.15 p.m.

Fri., March 28.—INTERNAL COMBUSTION ENGINE GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "The Ultimate Engine: Stationary, Rail Traction and Marine," 6 p.m.

INSTITUTION OF NAVAL ARCHITECTS

Tues., March 25.—Weir Lecture Hall, 10, Upper Belgrave Street, London, S.W.1, Annual General Meeting, 10.15 a.m.

Tues. to Thurs., March 25 *to* 27.—Weir Lecture Hall, 10, Upper Belgrave Street, London, S.W.1, 1958 Spring Meeting.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., March 24.—MIDLANDS REGION: Sibree Hall, Coventry, "Ceramic Tools," H. Eckersley, 7 p.m. ★ NORTH MIDLANDS REGION: Irongates Hotel, Derby, Annual General Meeting; Films, 7 p.m. ★ SCOTLAND REGION: St. Enoch Hotel, Glasgow, "Radio Isotopes," H. Seligman, 7.30 p.m. ★ GEORGE BRAY MEMORIAL LECTURE: Chemistry Lecture Theatre "A," The University, Leeds, "The Fabrication of Plastics," V. E. Yarsley, 6.30 p.m.

Tues., March 25.—HALIFAX AND HUDDERSFIELD GRADUATE SECTION: Technical College, Huddersfield, "All's Well that's Oiled Well," G. Scott; Film, "Diesel Lubrication," 7.30 p.m.

Wed., March 26.—MIDLANDS REGION: Technical College, Shrewsbury, Annual General Meeting, Films, 6.45 p.m. ★ MIDLANDS REGION: Cadena Café, Worcester, Annual General Meeting; Films, 7 p.m.

Thurs., March 27.—NORTH MIDLANDS REGION: Ruston Club, Lincoln, Annual General Meeting; Film, "G.F. Film on Copy Turning," 7.30 p.m. ★ SOUTH EASTERN REGION: ROCHESTER GRADUATE SECTION: The Old Palace, Maidstone, Kent, "Philosophy of Incentives," 7.30 p.m.

Fri., March 28.—WALES REGION: South Wales Institute of Engineers, Park Place, Cardiff, Annual General Meeting; "Nylon—A New Engineering Material," T. W. Currie, 7 p.m. ★ NORTH WESTERN REGION: Technical College, Abbey Road, Barrow-in-Furness, "The Electronic Control of Machine Tools," D. T. N. Williamson, 7.30 p.m.

Mon., March 31.—LIVERPOOL GRADUATE SECTION: Radiant House, Bold Street, Liverpool, Annual General Meeting; Films, 7.30 p.m. ★ NORTH WESTERN REGION: College of Science and Technology, Sackville Street, Manchester, "Ceramic Cutting Tools," G. R. Connor, 7.15 p.m.

INSTITUTION OF RUBBER INDUSTRY

To-day, March 21.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Joint Meeting with Plastics Institute, "The Impact of Atomic Energy on Rubber and Plastics," R. Roberts, and "The Application of Rubber and Plastics in the Atomic Energy Field," 6.45 p.m.

Mon., March 24.—MANCHESTER SECTION: Grand Hotel, Manchester, "Ageing of Rubber: Effects of Metallic Contamination," B. N. Leyland and R. L. Stafford, 6.45 p.m.

Mon., March 31.—LEICESTER SECTION: Bell Hotel, Leicester, Annual General Meeting; Short Papers Evening, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., March 25.—LONDON GRADUATES' AND STUDENTS' SECTION: 11, Upper Belgrave Street, London, S.W.1, "Structural Economics," E. L. Parrinder, 6.30 p.m.

Thurs., March 27.—LONDON BRANCH: 11, Upper Belgrave Street, London, S.W.1, "Housing the Dounreay Fast Reactor," N. T. Barrett, 6 p.m.

Fri., March 28.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Birmingham, "Prestressed Concrete," A. J. Harris, 6 p.m.

INSTITUTION OF WORKS MANAGERS

Mon., March 24.—GLASGOW BRANCH: St. Enoch Hotel, Glasgow, "Radio Isotopes," H. Seligman, 7.30 p.m.

Thurs., March 27.—LANCASTER GROUP: Royal King's Arms Hotel, Lancaster, "Human Factors in Work Study," T. Lupton, 7.30 p.m.

Fri., March 28.—NOTTS AND DERBY BRANCH: Grandstand Hotel, Nottingham Road, Derby, "Brush Up Your Management," J. Bolton, 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 21.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Films, 7 p.m.

Fri., March 28.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Photocopying and the Drawing Office," G. V. Rickards, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, March 21.—Engineers' Club, Albert Square, Manchester, 2, "The Manchester University Radio Telescope," H. C. Husband, 6.45 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, March 21.—Lecture Theatre, Mining Institute, Newcastle upon Tyne, "Velocity Measurements in Close Proximity to a Ship's Hull," R. S. Cutland, 6.15 p.m.

Wed., March 26.—TEES-SIDE BRANCH: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Welding in Ship Repairing," N. G. Hanson, 6 p.m.

PLASTICS INSTITUTE

Tues., March 25.—LONDON AND DISTRICT SECTION: Wellcome Building, 183–193, Euston Road, London, N.W.1, "Plastics in the Automotive Industry," R. Rajan, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., March 25.—SCOTTISH BRANCH: North British Hotel, Princes Street, Edinburgh, "The Scottish Agricultural Industries, Ltd., Leith Development," L. Gordon, 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., March 27.—THIRTEENTH BRITISH COMMONWEALTH LECTURE: Institution of Civil Engineers, Great George Street, London, S.W.1, "Why Airlines are Hard to Please," B. S. Shenstone, 6 p.m.

ROYAL INSTITUTION

To-day, March 21.—WOODHULL LECTURE: 21, Albemarle Street, London, W.1, "The Control of Evolution in Man," C. D. Darlington, 9 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., March 31.—ORDINARY GENERAL MEETING: 12, Great George Street, Westminster, London, S.W.1, "The Preservation of Georgian and Victorian Architecture," J. Summerson, 5.45 p.m.

ROYAL STATISTICAL SOCIETY

Thurs., March 27.—LEICESTER GROUP: Room 104, Leicester College of Technology, The Newarke, Leicester, "Methods of Productivity Measurements," T. E. Easterfield, 7 p.m. ★ SHEFFIELD GROUP: Y.M.C.A., 49, Fargate, Sheffield, 1, "Automatic Sales Forecasting," A. Muir, 7 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION

Tues., March 25.—B.I.S.R.A., Hoyle Street, Sheffield, "The Acid Bessemer Process of To-day," F. B. Cawley, 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Fri., March 28.—CORROSION GROUP: The Robinson Lecture Theatre, The University, Manchester, "Recent Research on the Corrosion of Boiler Tubes," E. C. Potter, 6.30 p.m.

SOCIETY OF ENGINEERS

Mon., March 31.—Geological Society, Burlington House, London, W.1, "Soil in British Railway Civil Engineering," A. H. Toms 5.30 p.m.

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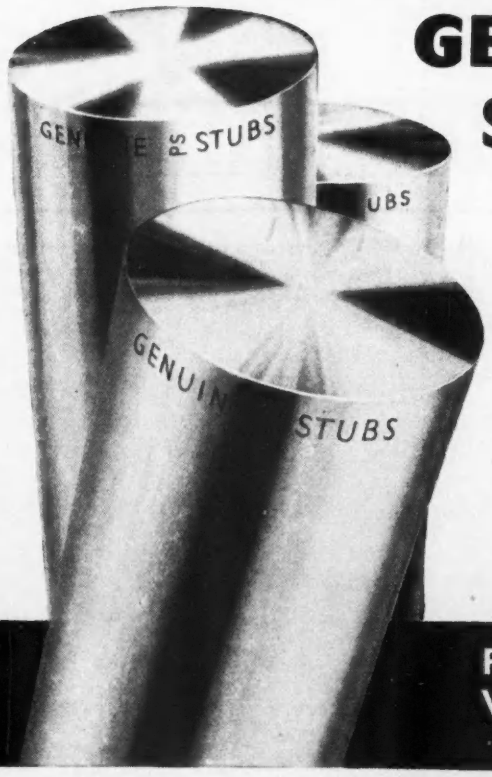

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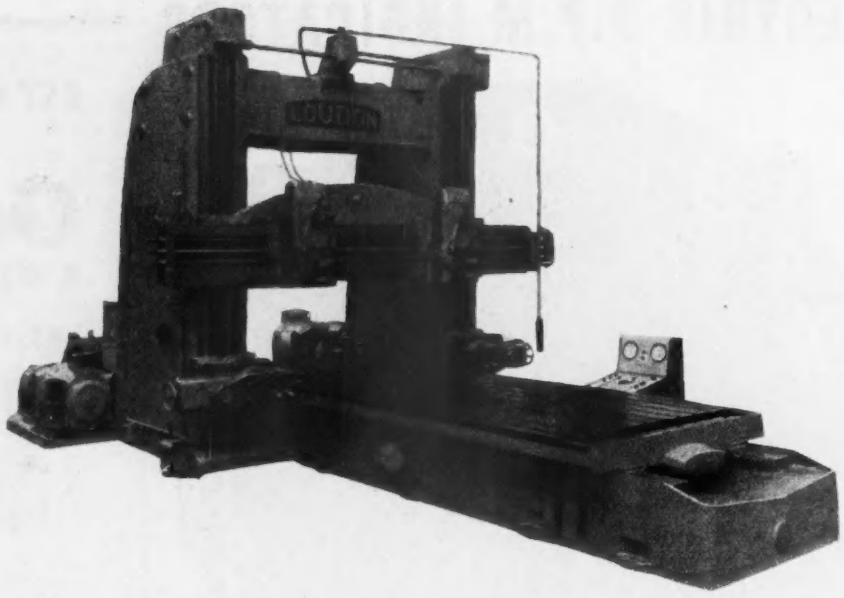

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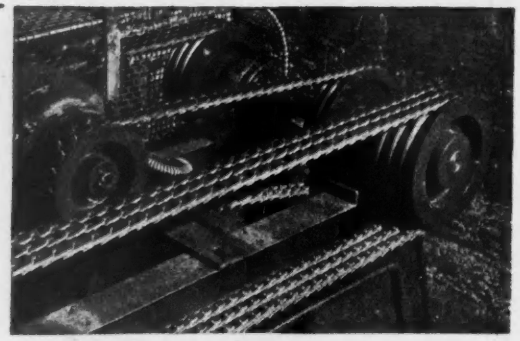

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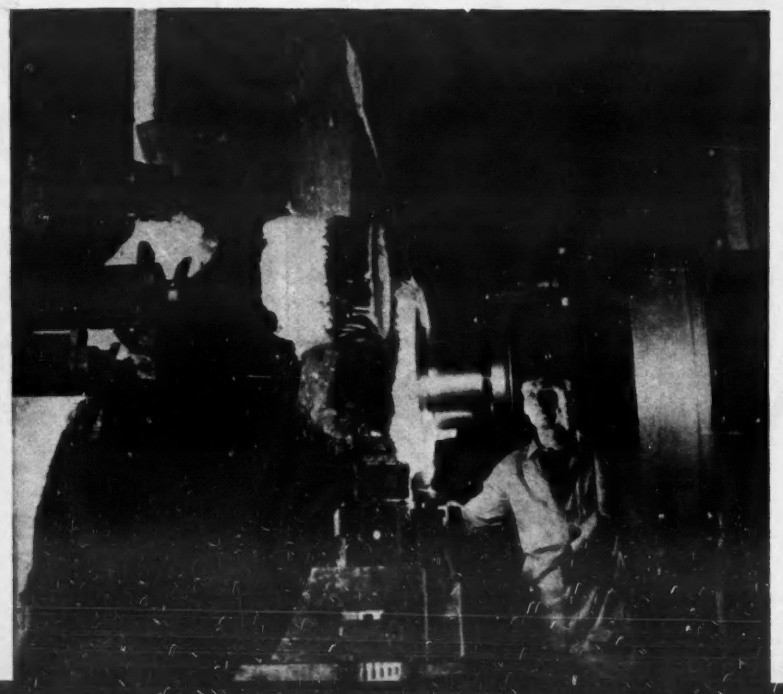

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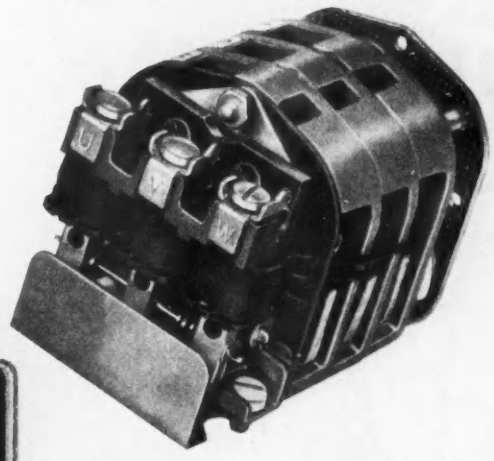

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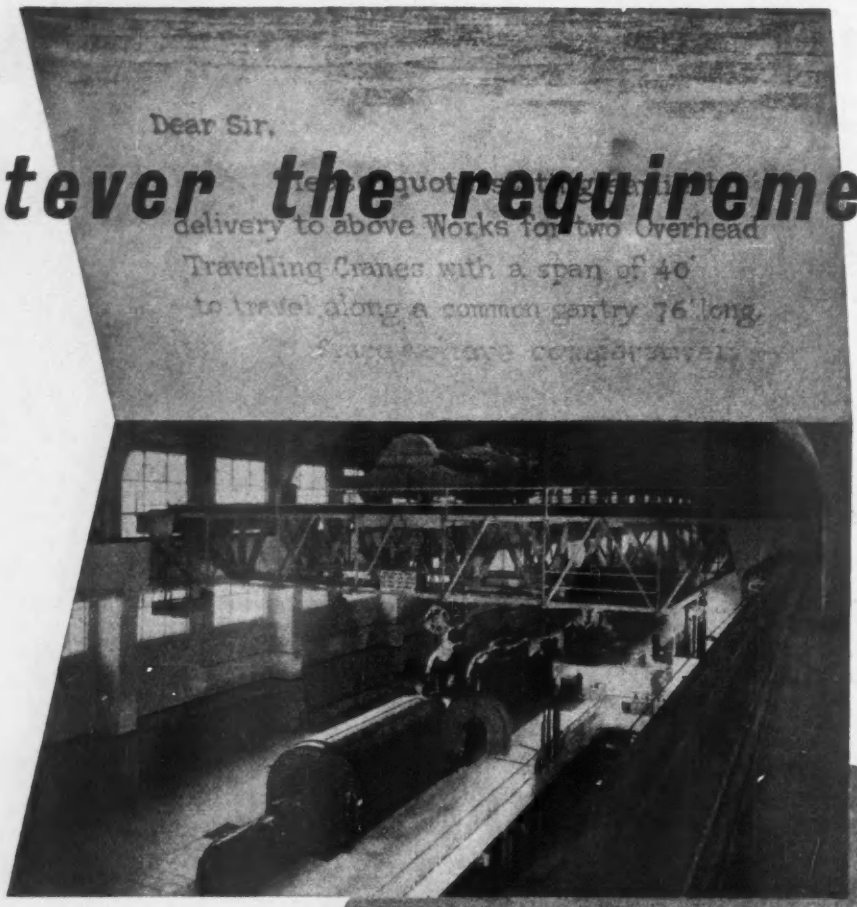
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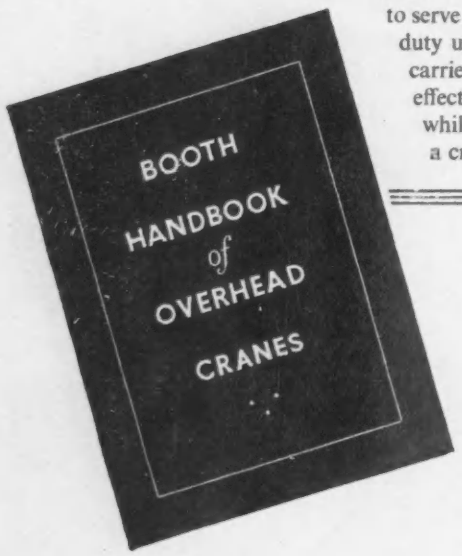

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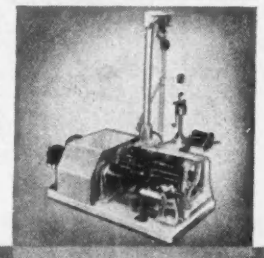

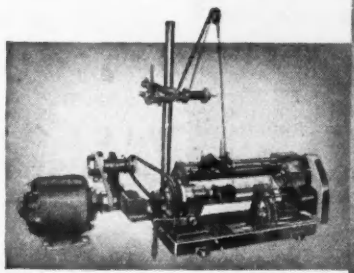

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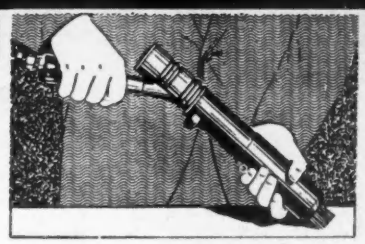

The Jason Pistol helps the engineer to defeat his biggest enemy—rust. It will remove rust from steel, iron and other metals quickly and efficiently.

Its applications include: Removing rust, roughing up steel, etc., for metallising, cleaning castings and removing cores, removing paint and bitumen, cleaning all types of machinery (especially in awkward corners), to mention but a few.

Jason Pistols are air-operated hand tools with trigger control requiring 12.5 cu. ft. of compressed air per minute at 90 lbs. sq. inch pressure. The complete Pistol Kit consists of the Pistol with holder for the 65 × 2 mm. flat end needles and 28 × 3 mm. chisel end and pointed needles. Two interchangeable mouthpieces are provided, one round for normal work and one straight for cleaning fillets, angles, bolt heads, etc.

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PACKAGED BOILER

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GUARANTEED 82.5% EFFICIENCY

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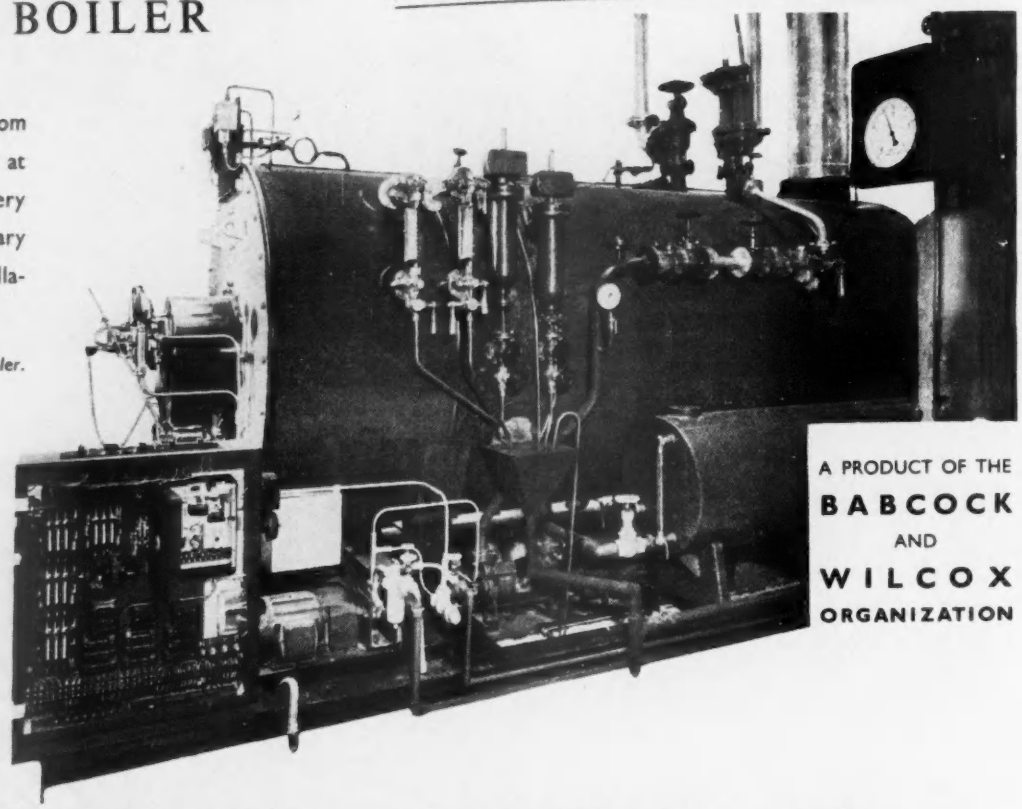
Send for Publication No. 1628/3—The Steambloc Packaged Boiler.



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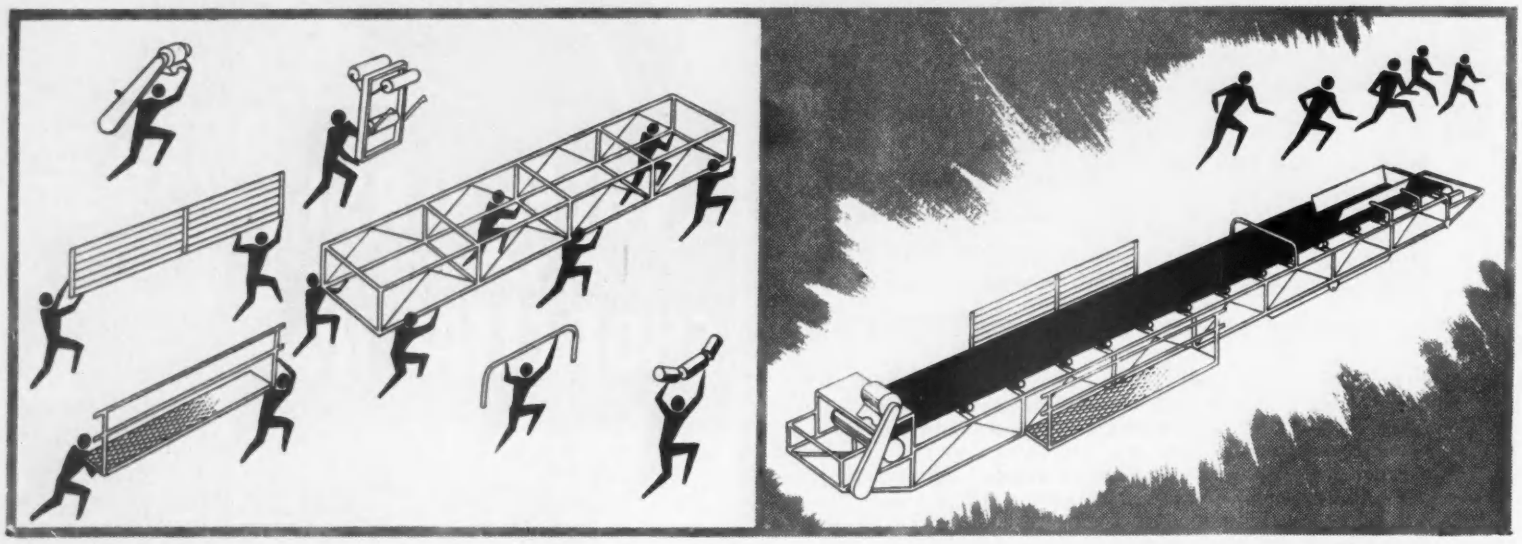

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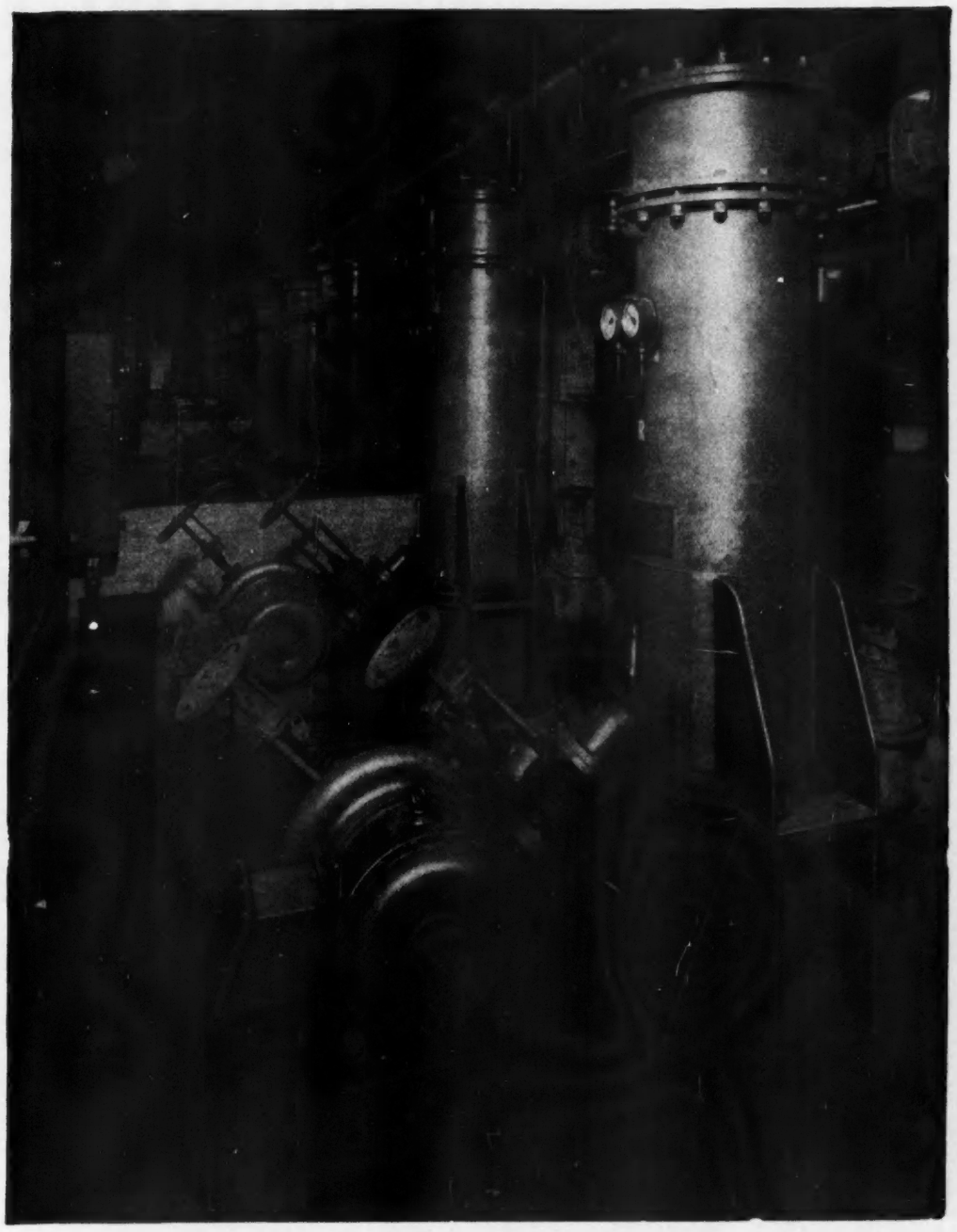

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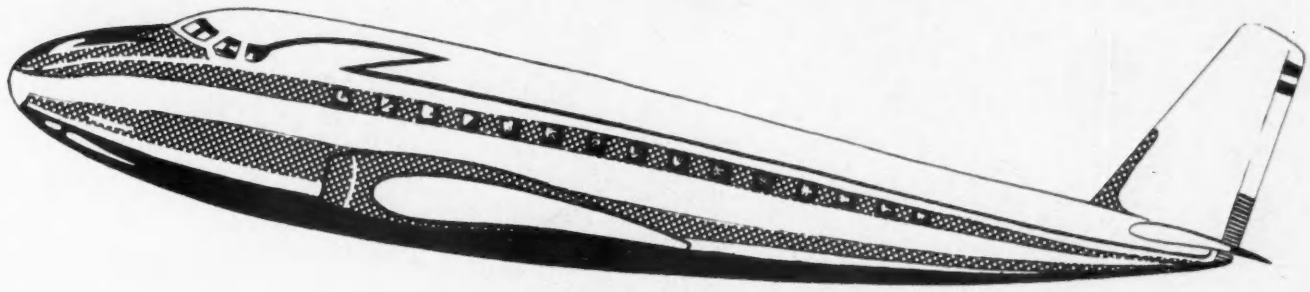

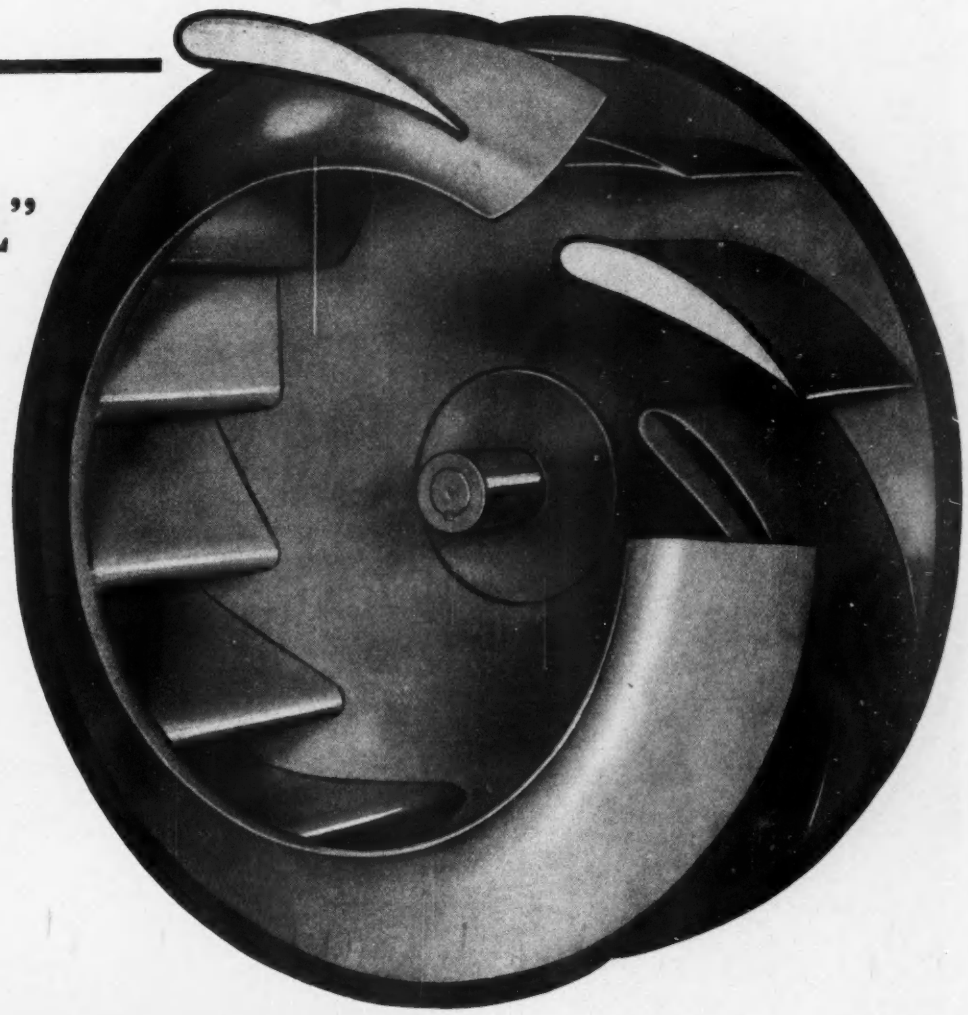

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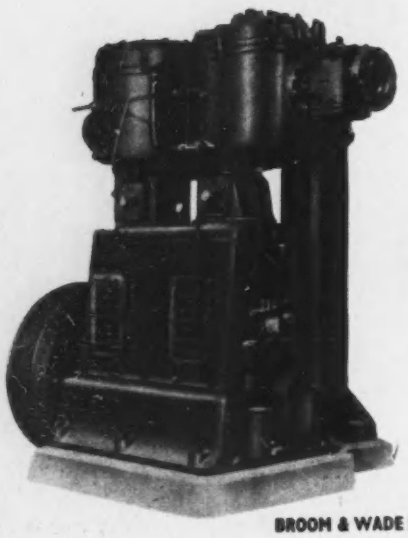

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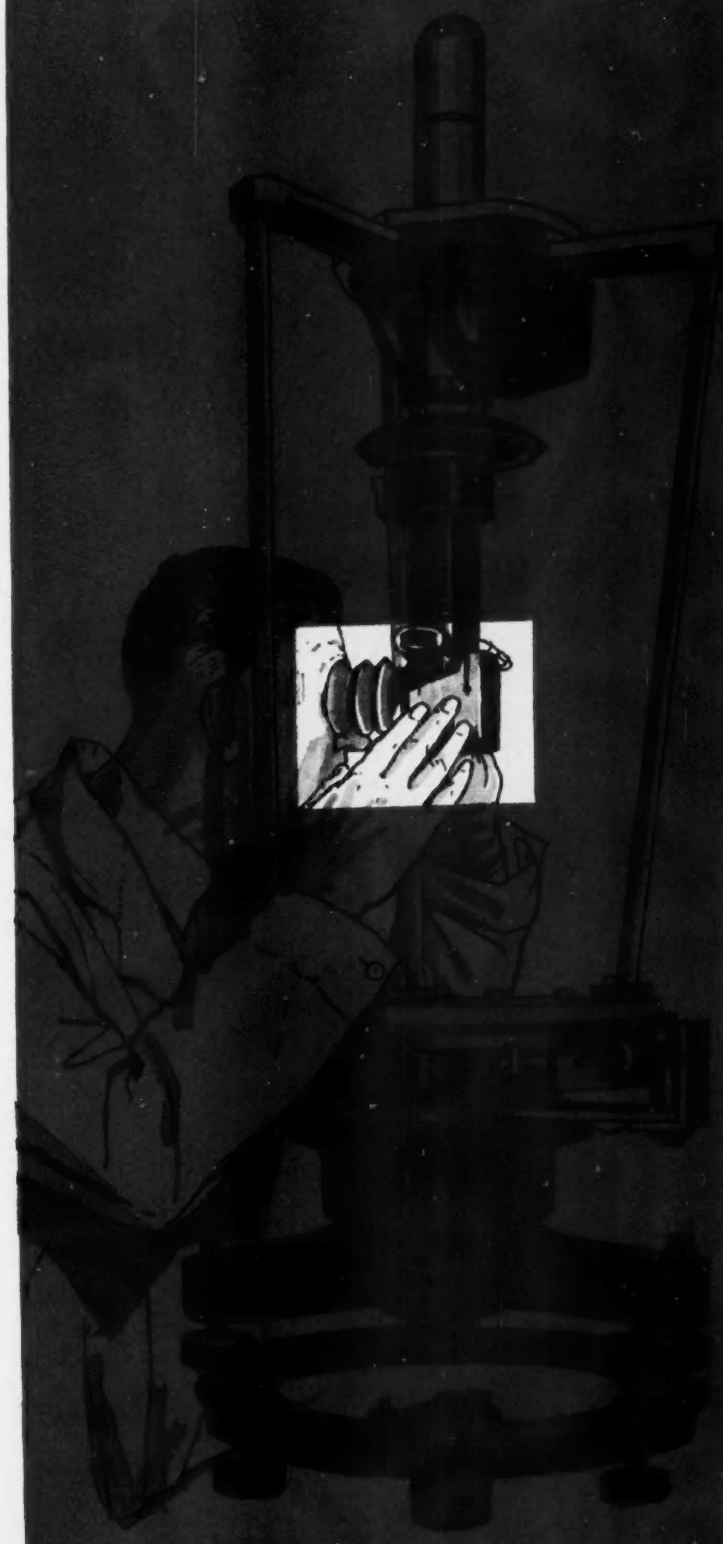
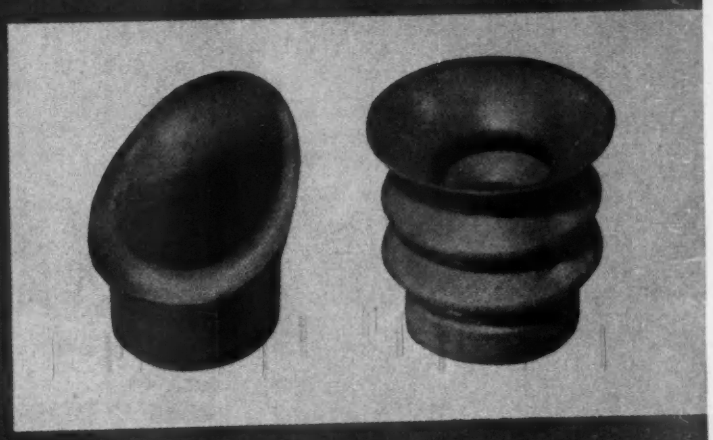
I.C.I. Silicone Rubbers are worth looking into



Aircraft sextants and periscopes must operate perfectly at the low temperatures encountered in high-altitude flights. So even the flexible eyepieces of these instruments present a problem—for natural rubber becomes too rigid under these conditions. I.C.I. Silicone Rubbers, however, retain their flexibility—and many other desirable properties—over a very wide temperature range. In this case they completely met the requirement for operation at −40°C. And they will meet other specifications, too, from 250°C to −80°C. If you have a problem within this range—electrical, chemical or mechanical—I.C.I. Silicone Rubbers are certainly worth looking into.



Periscope instruments for aircraft, manufactured by Kelvin and Hughes Ltd., with eyepieces of I.C.I. Silicone Rubber moulded by Waltham Rubber and Plastics Ltd.

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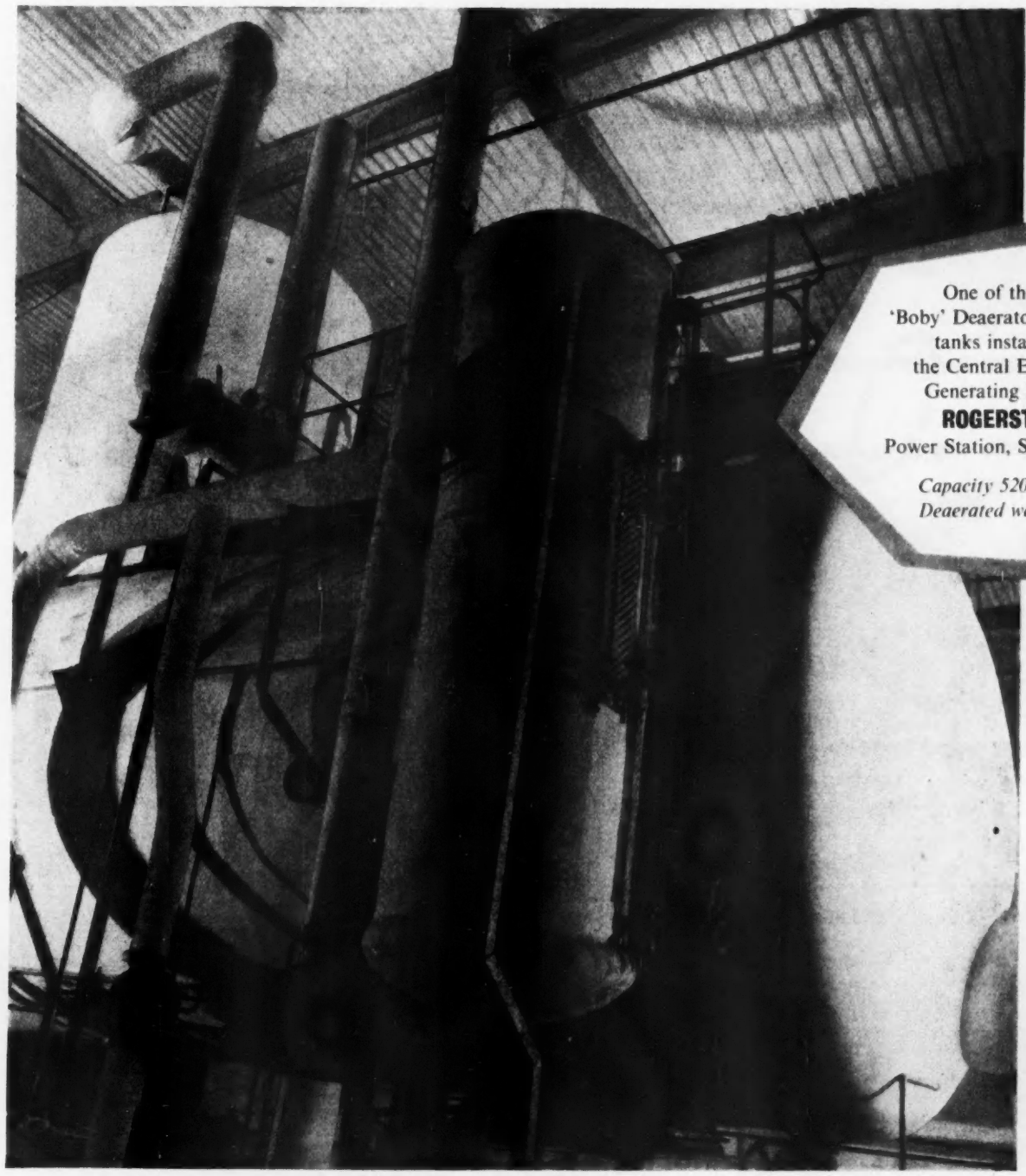

One of the two 'Boby' Deaerators and feed tanks installed at the Central Electricity Generating Board's **ROGERSTONE** Power Station, South Wales.

Capacity 520,000 p.p.h. Deaerated water.

A 'Boby' Deaerator has been installed, or is being installed, as part of the feed heating system of each of Messrs. C. A. Parsons & Co's turbo-generating sets in the following modern power stations:—

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Power Stations Abroad

3 — 60 M.W. sets at Lake Macquarie, Australia
2 — 66 M.W. sets at Boundary Dam, Canada
2 — 66 M.W. sets at Selkirk, Canada
1 — 15 M.W. set at Hunts Bay, Jamaica
2 — 25 M.W. sets at Monterey, Mexico

All these 'Boby' Deaerators are fitted with the special 'Boby' weight loaded deaerating nozzles, deaerating trays, flash suppressor device and all necessary steam pressure and water level controls to ensure a continuous supply of deaerated water to the boiler feed pumps under all load conditions. The guaranteed maximum residual is, in most cases, 0.005 c.c./litre.

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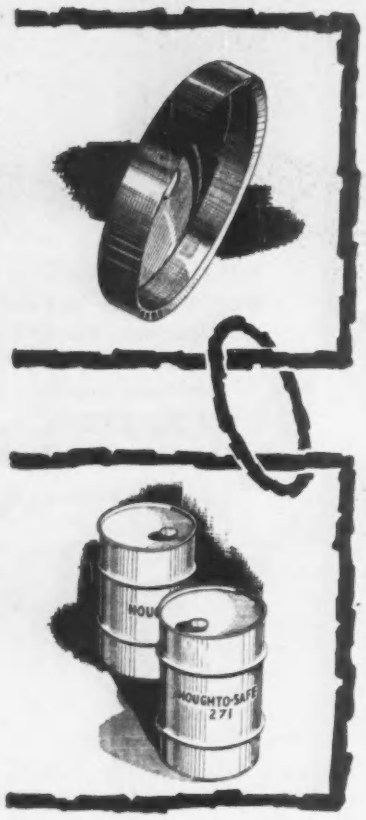

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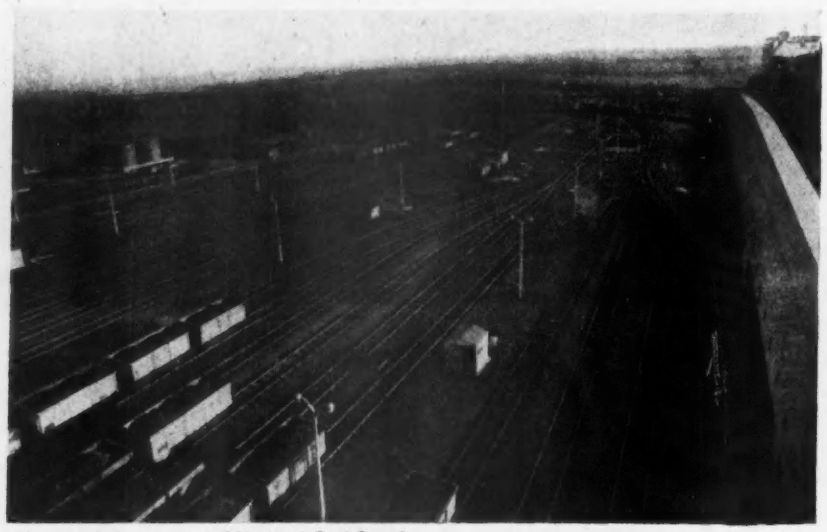
MANVERS CENTRALIZATION SCHEME:

From the top of the newly constructed Coal preparation plant: a small section of the immense network of railway sidings

The supply and installation of these sidings and the adjoining trackwork for the new Coal Carbonization and Benzole Rectification Schemes were entrusted to the Eagre Construction Co., Ltd., by the National Coal Board. Over 9,000 tons of Iron and Steel were used in the construction of the forty miles of track and 230 turnouts and Special Point and Crossing layouts comprising the combined railway Sidings.

Eagre's skilful planning and practical experience in the day-to-day working of Colliery Sidings ensured that this vast scheme was laid efficiently to schedule, and without the slightest interruption of existing Colliery traffic.



Photograph by courtesy of National Coal Board

WORK BEGINS AT CADEBY:

The National Coal Board again entrusts the Eagre Construction Co. Ltd. with a similar project. Earthworks, Drainage, Track Laying and ancillary works for thirteen miles of Sidings are now in progress at Cadeby Main.

for a complete Track Service

Photograph by courtesy of National Coal Board

In addition to its activities in the Nation's Coalfields, the Eagre Construction Co. Ltd. has worked continuously during the past ten years for British Railways, the Gas Board, the United Steel Companies, and has carried out large Power Station Projects for the Central Electricity Authority.

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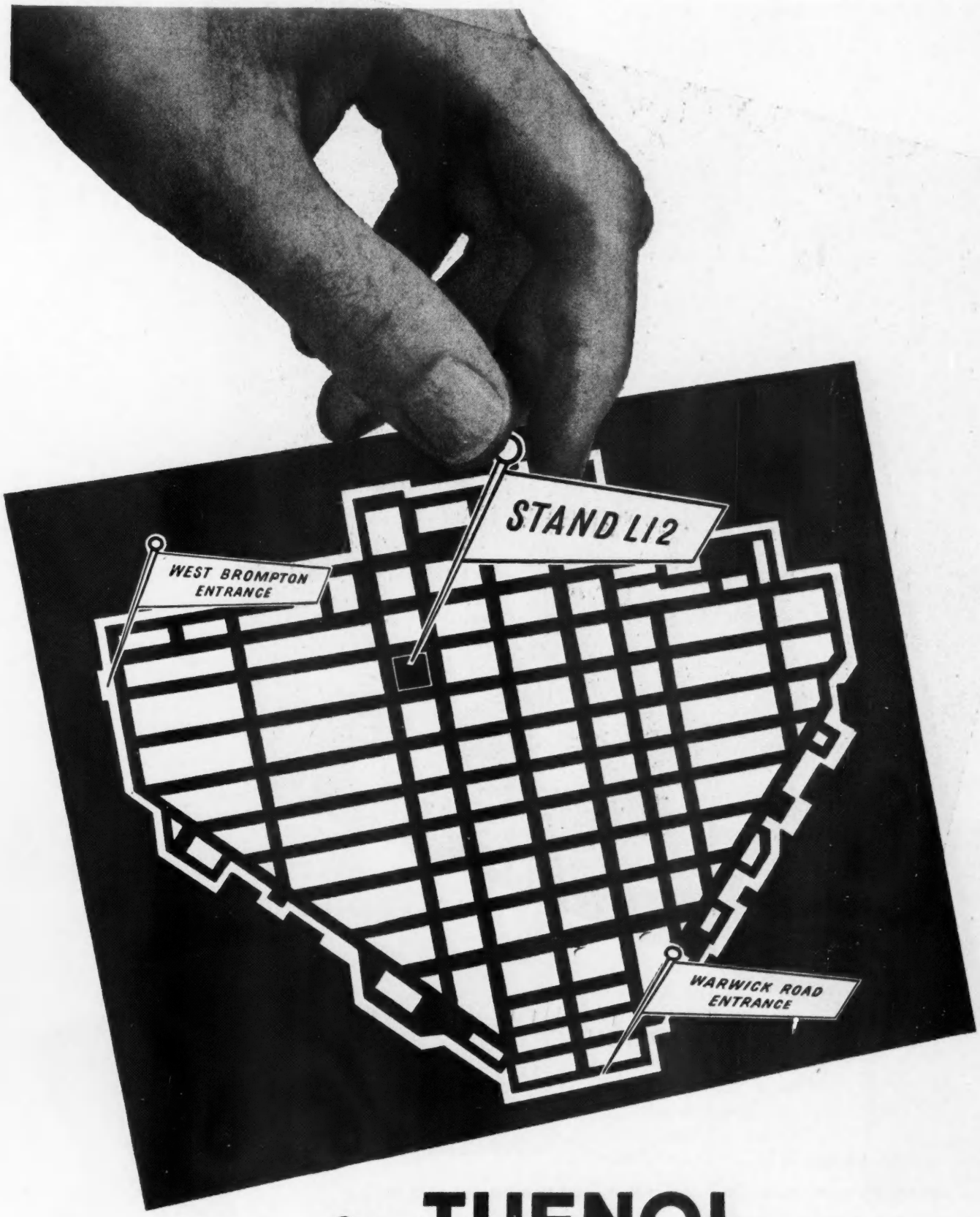

See **TUFNOL**
(REGISTERED TRADE MARK)

the mechanically strong electrical insulator

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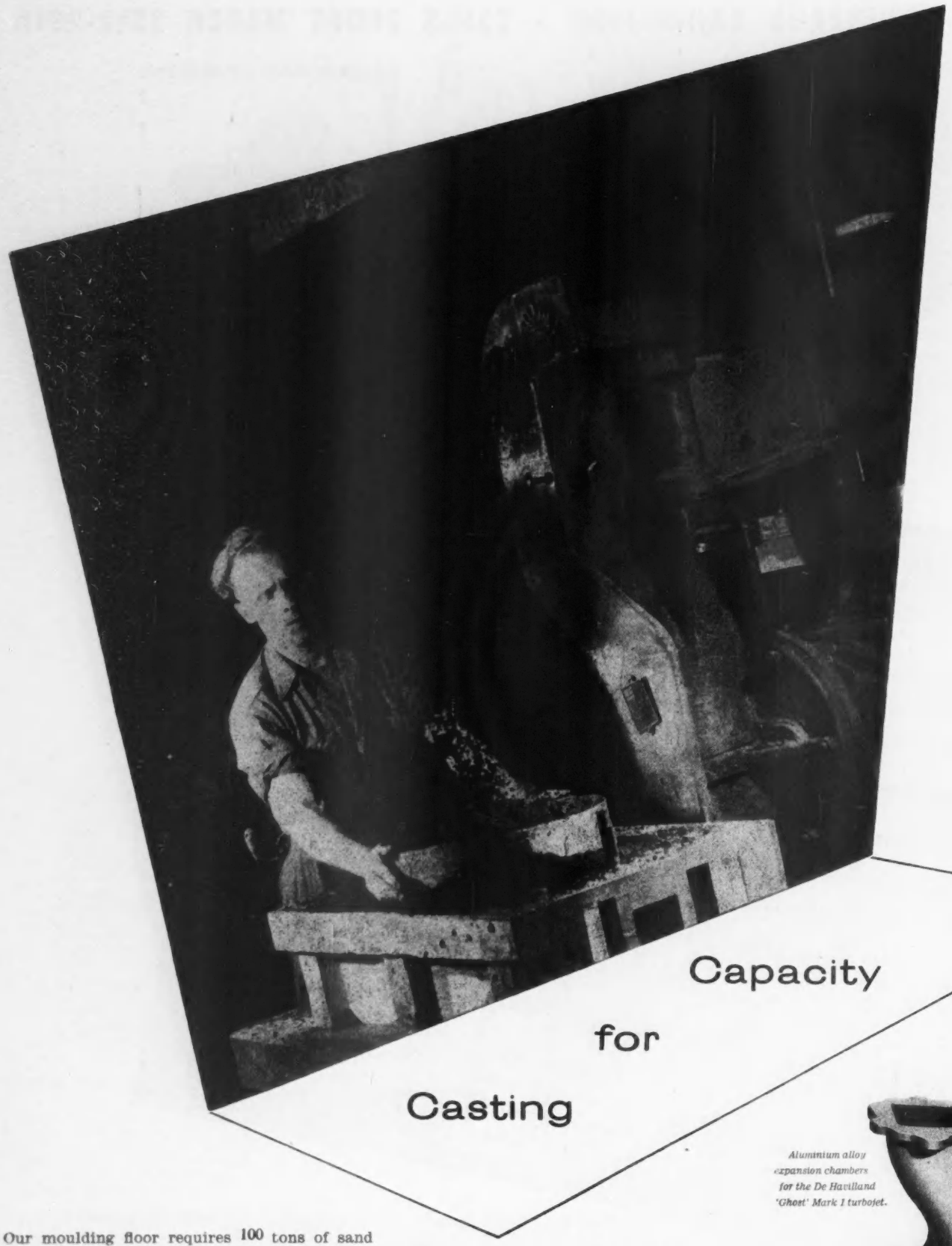

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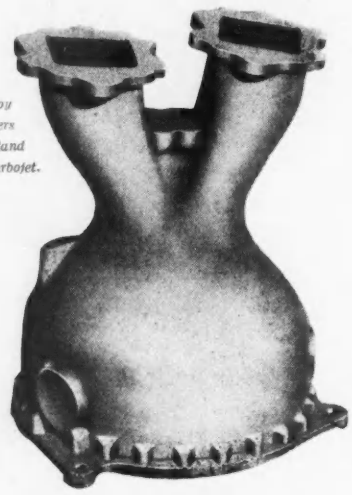
Our moulding floor requires 100 tons of sand daily from the sand preparation plant. The prepared sand is distributed by belt conveyor to hoppers at the moulding stations. The photograph shows an operator riddling sand on to a pattern mounted on one of a battery of jolt, squeeze, turnover pattern draw machines in our sand foundry.



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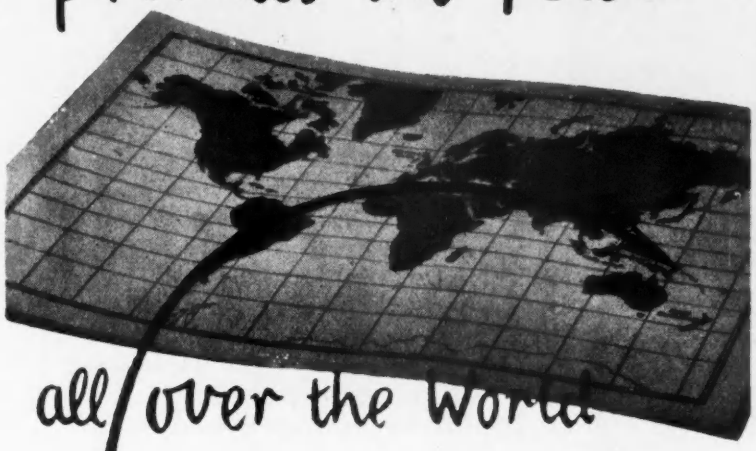
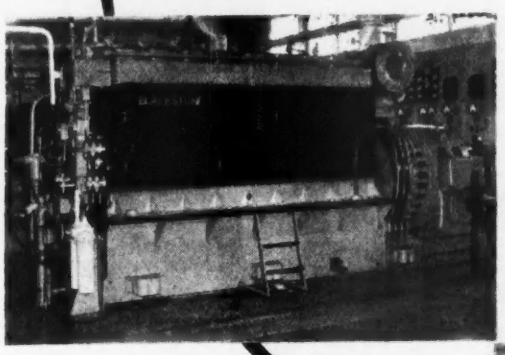
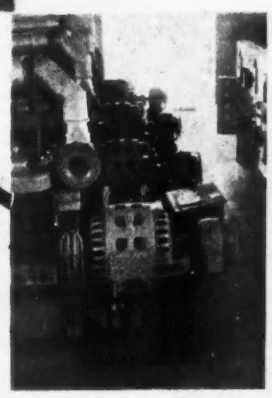


all over the world



IN RABAUL,

New Britain, electricity is supplied by four 320 kW alternators, each powered by a Lister Blackstone EVS8 480 h.p. diesel engine.



Photos by courtesy of the Commissioners of Australia Dept. of Works & Housing.

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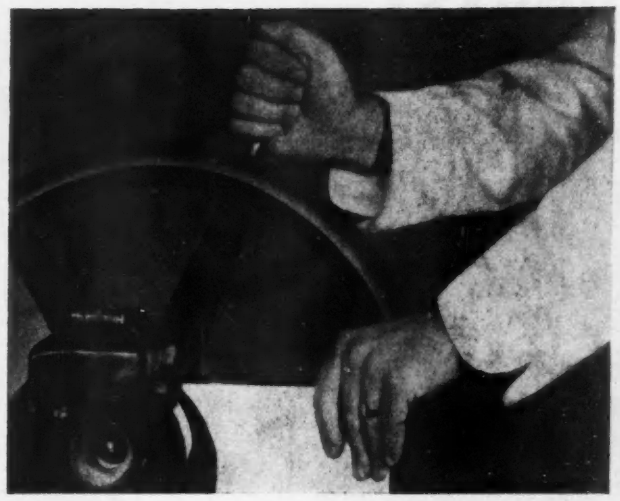

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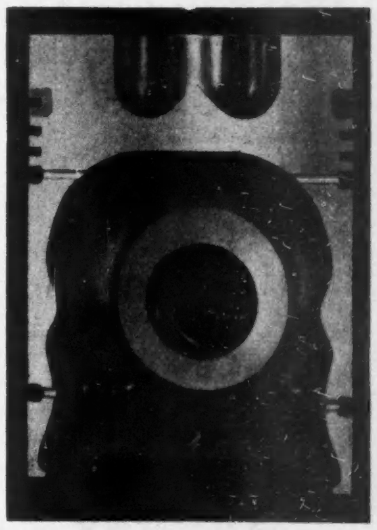
...more than pay for themselves in the first year!



The top ring groove of the Al-Fin Piston has an austenitic cast iron insert bonded to the alloy giving strength where it is most required, increasing piston life by at least 100%. This double mileage saves you the cost of one overhaul *and* the cost of another set of pistons! *Write for leaflet S20/1.*

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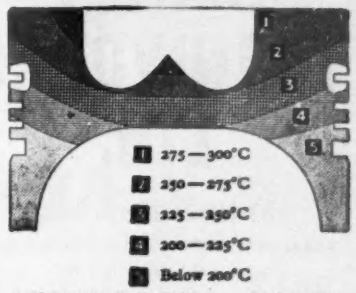
- Avoidance of localised hot areas.
- Correct gudgeon pin alignment.
- That head thickness, coupled with correct blending into piston wall, overcomes distortion of ring grooves. This has considerable bearing on blow-by and efficient oil control.



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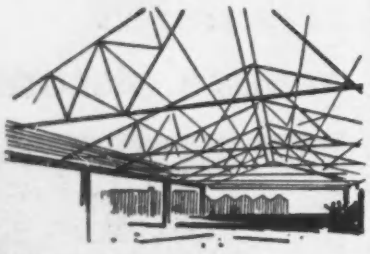

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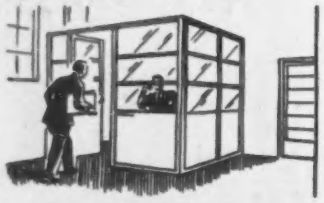

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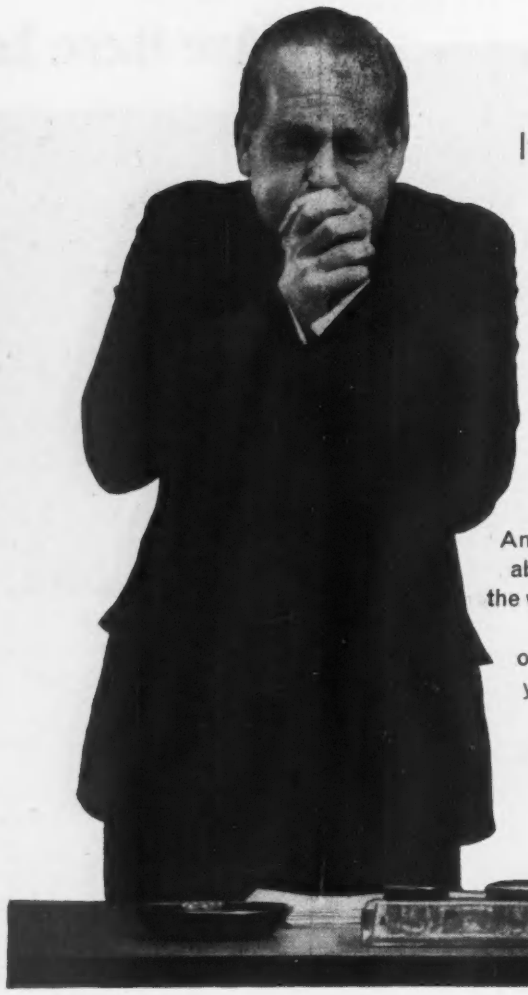

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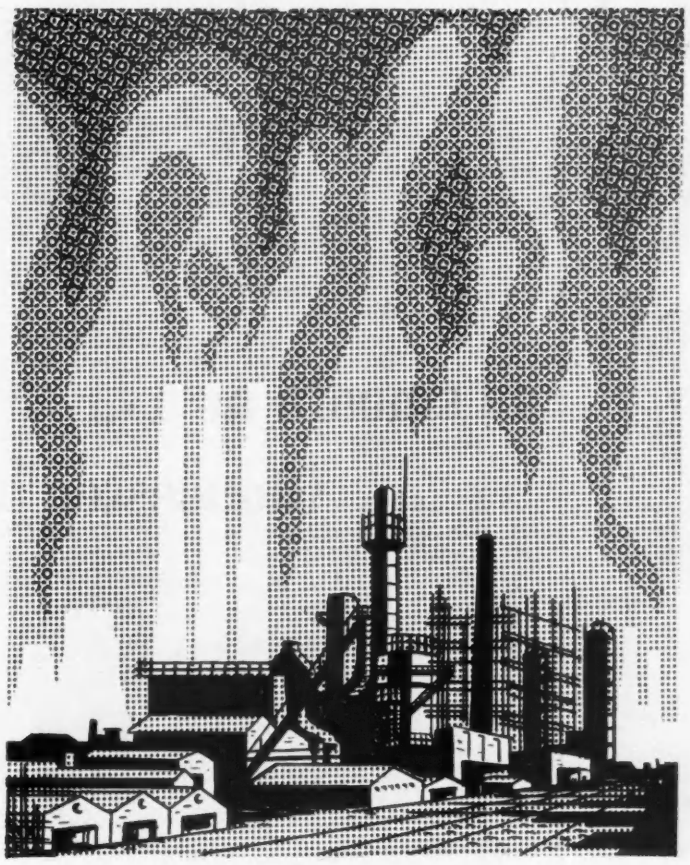

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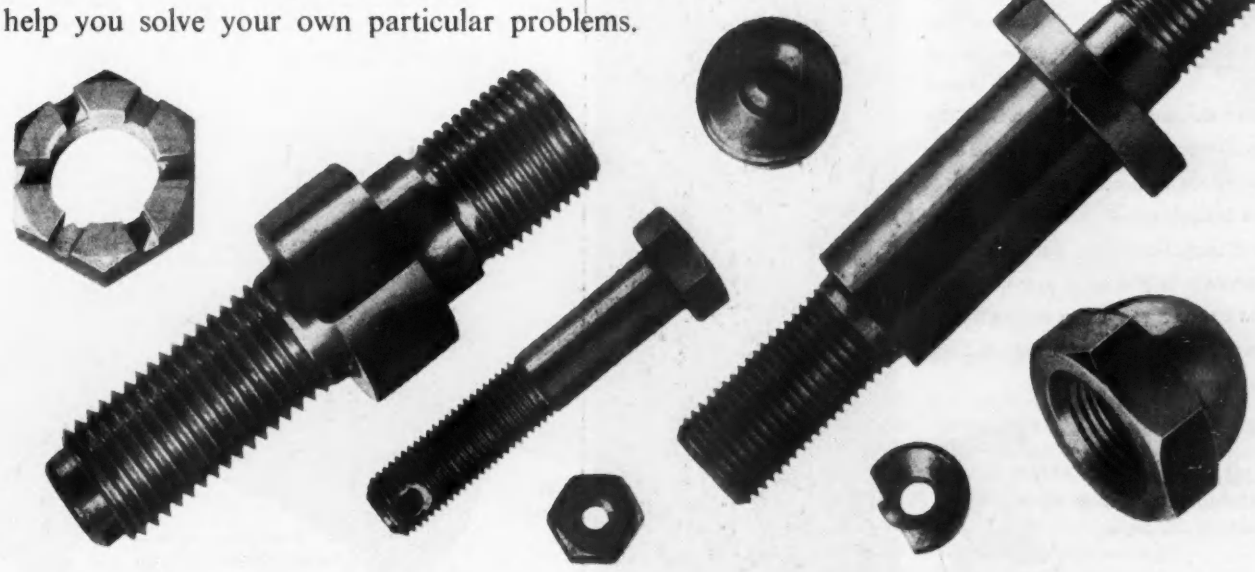

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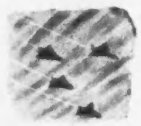

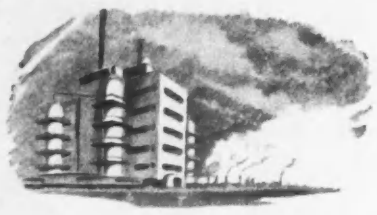

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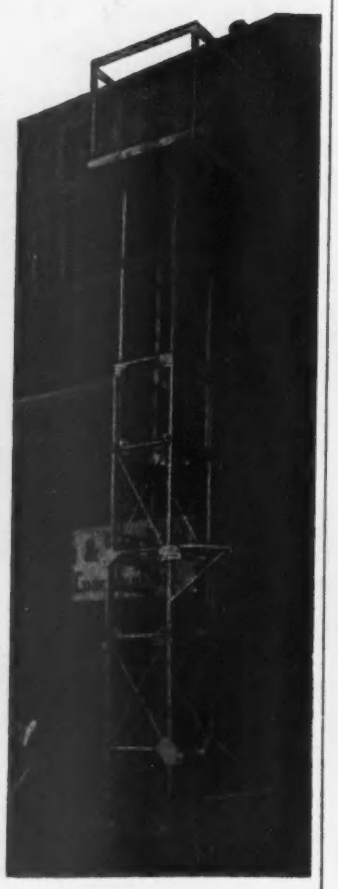

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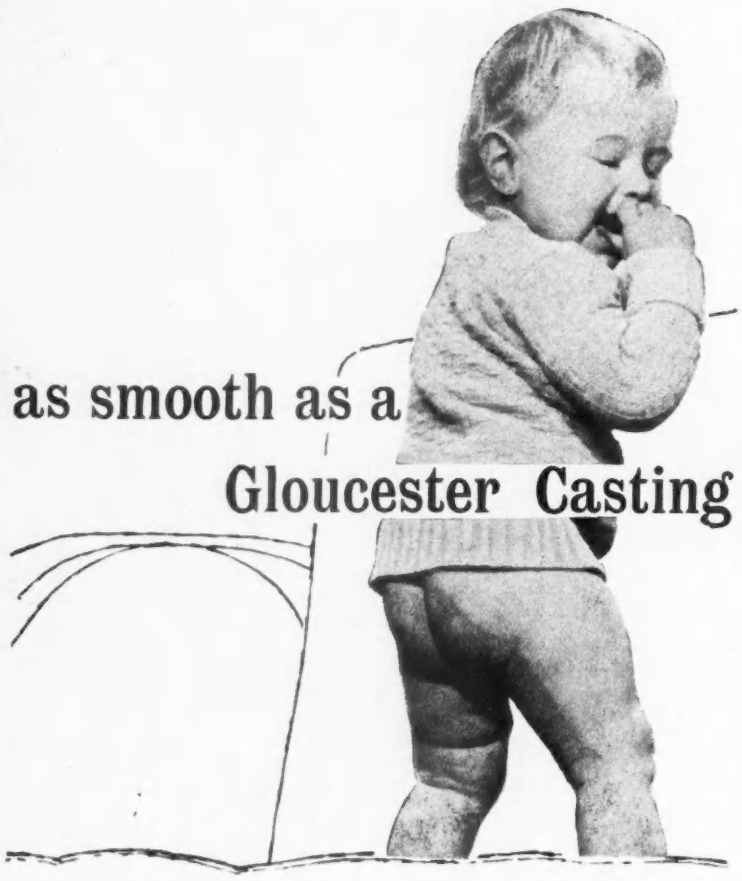

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Spring mounting bracket in Malleable Iron Weight 8½ lbs.

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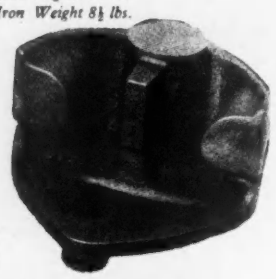

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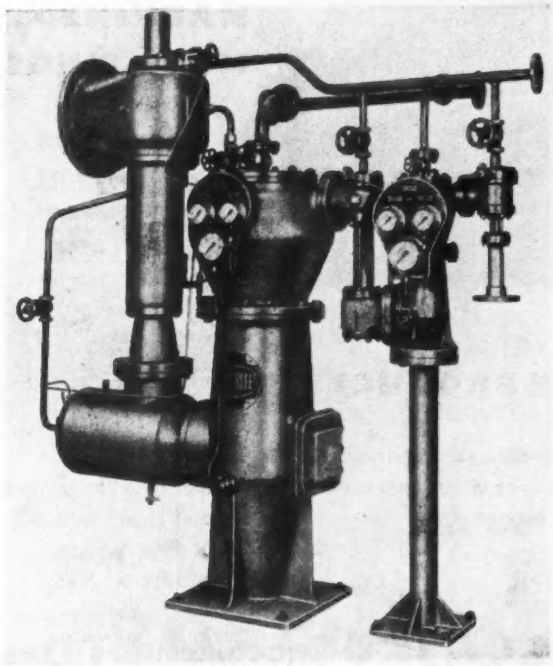

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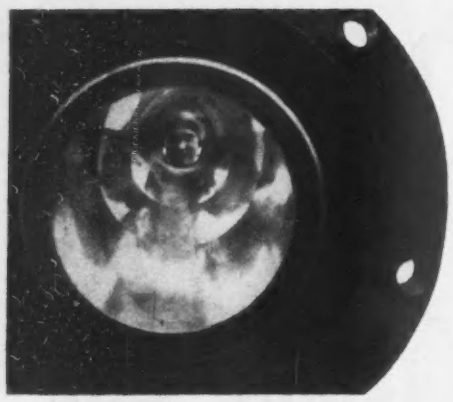

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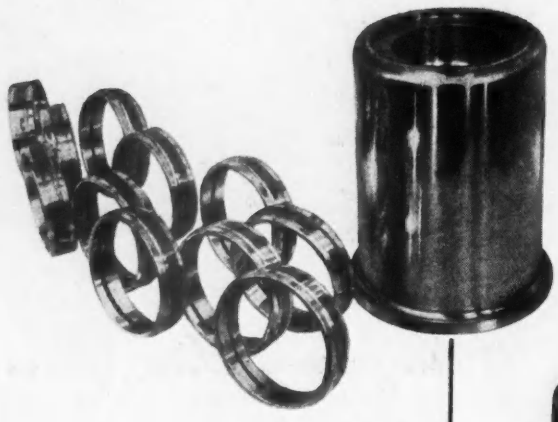

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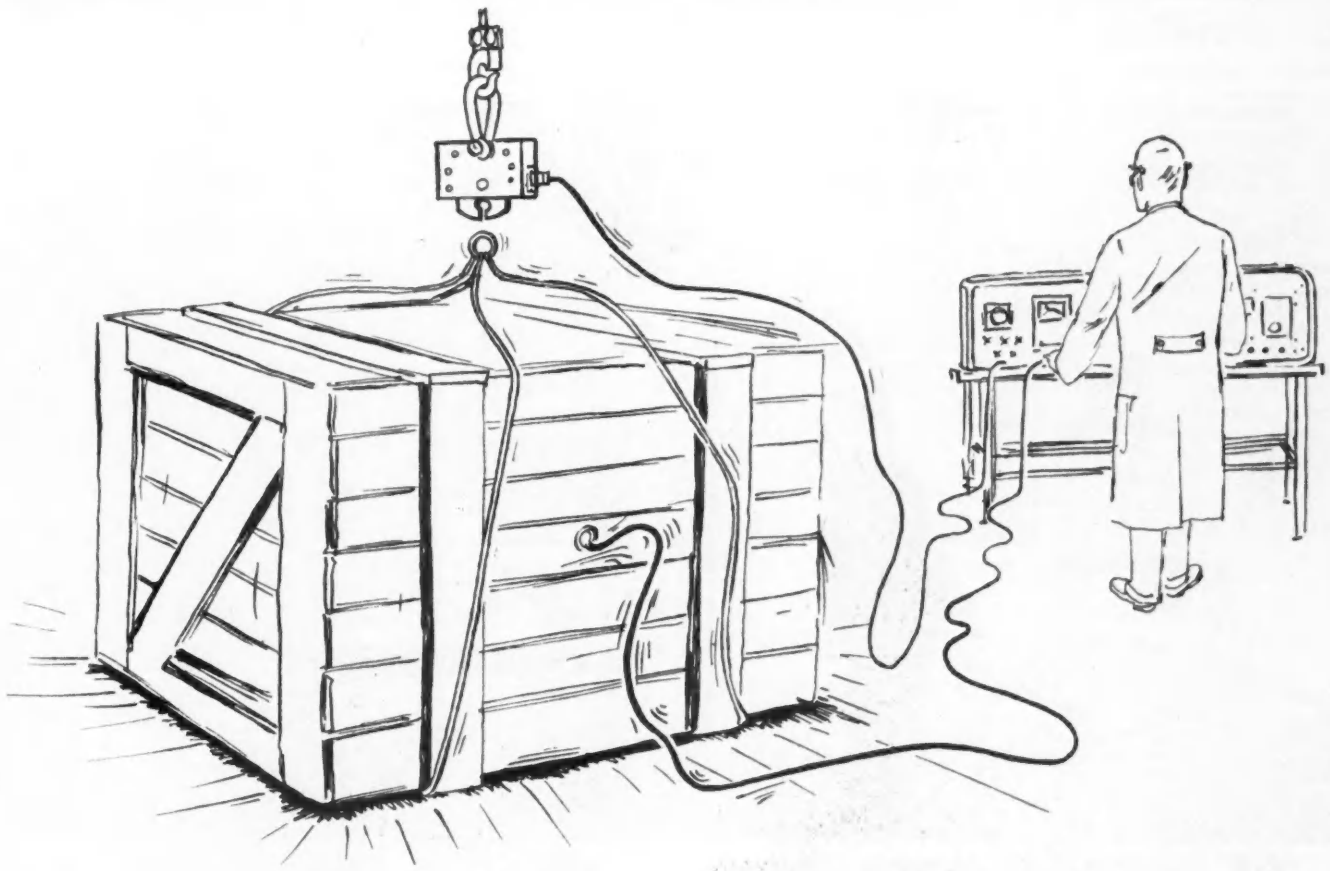

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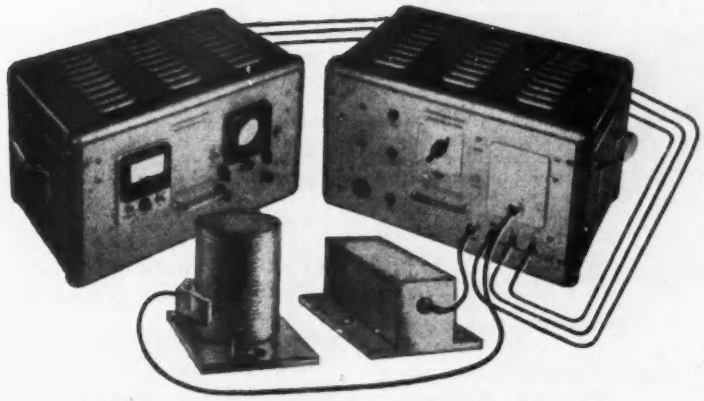

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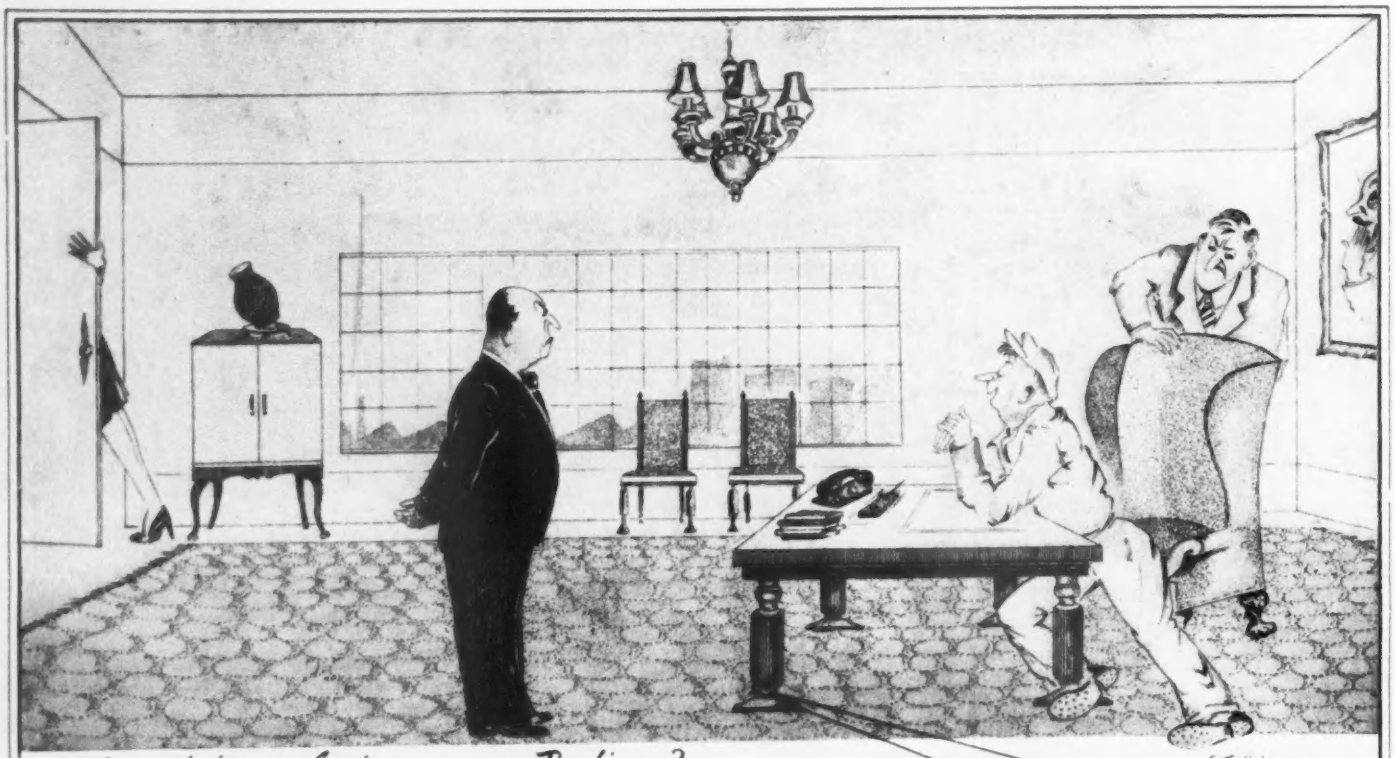

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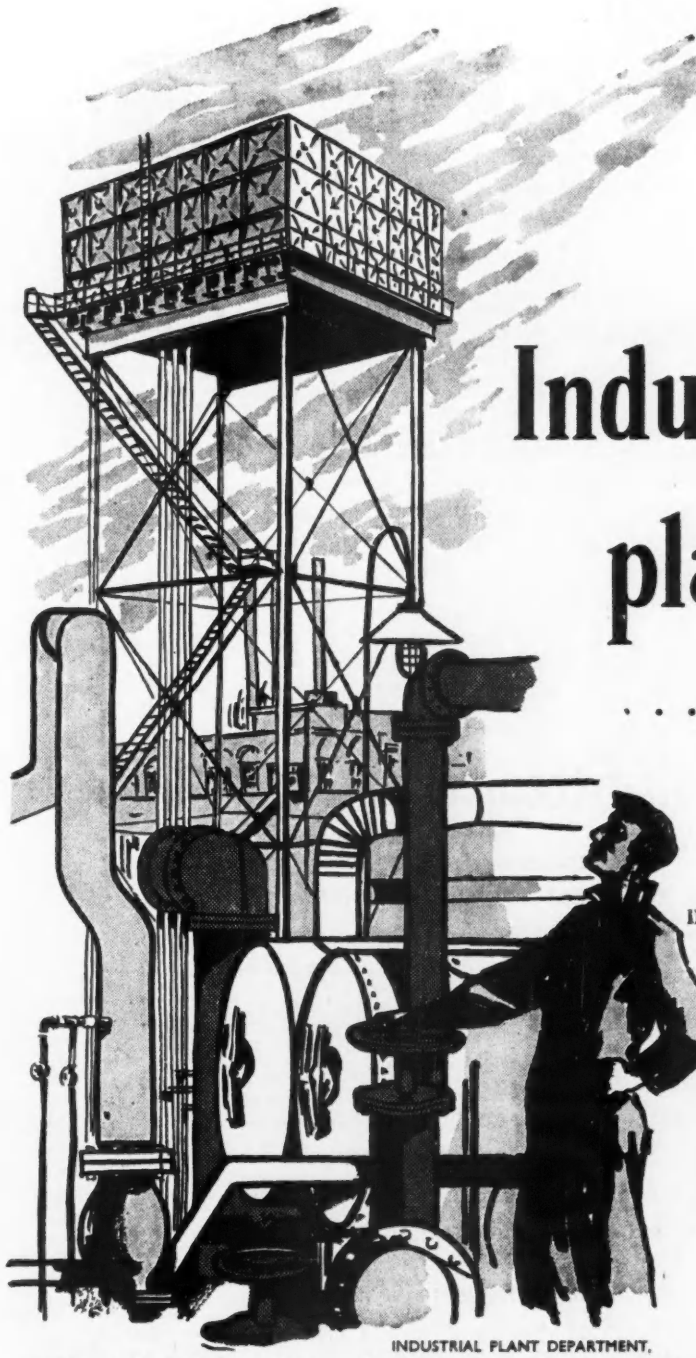

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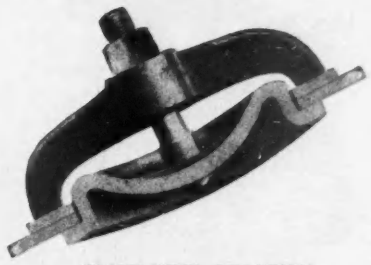

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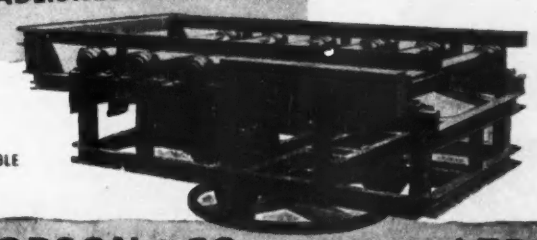

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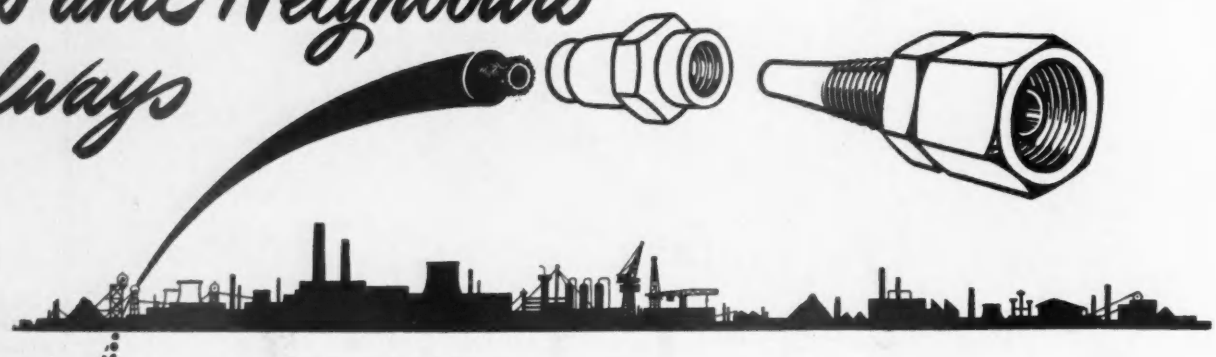

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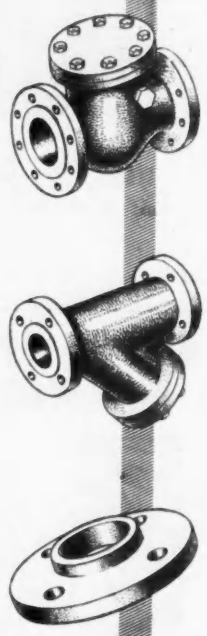

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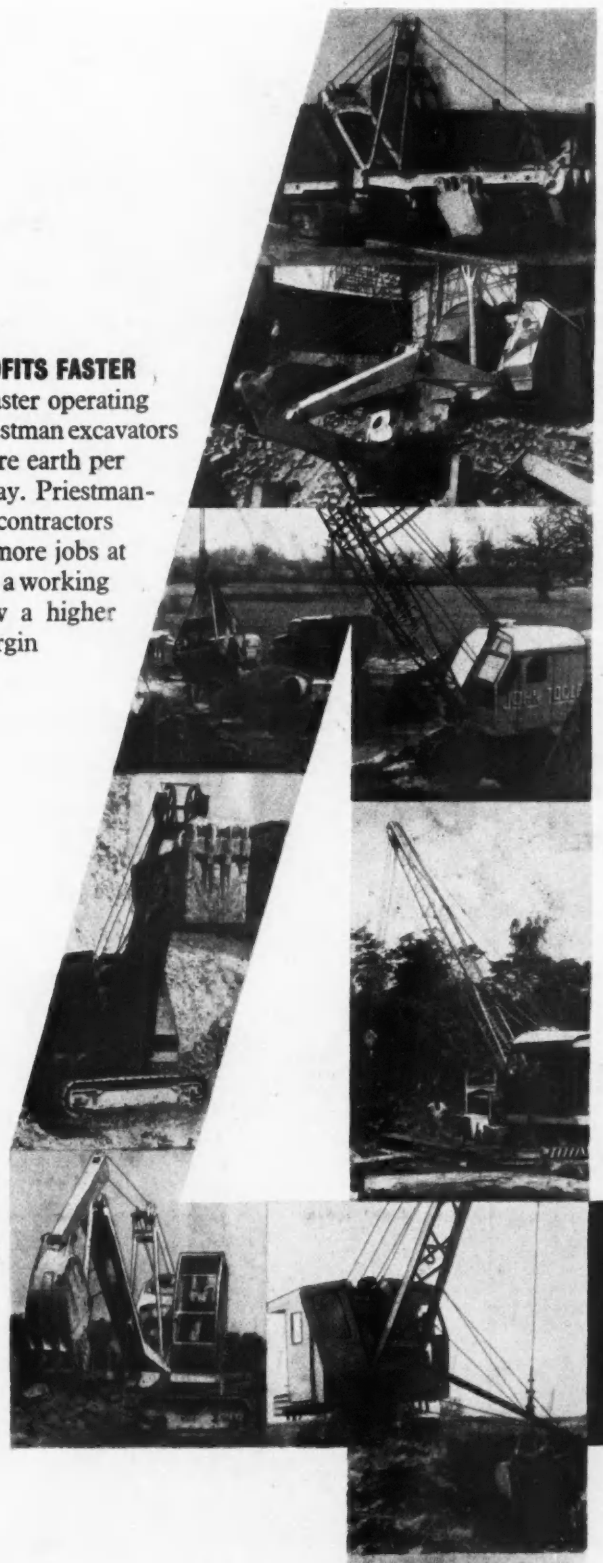

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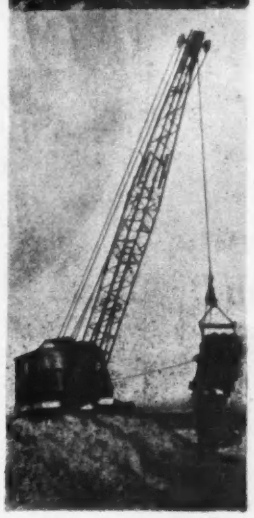

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It is the smallest handtool capable of welding both ferrous and non-ferrous studs up to ⅜ in. diameter.

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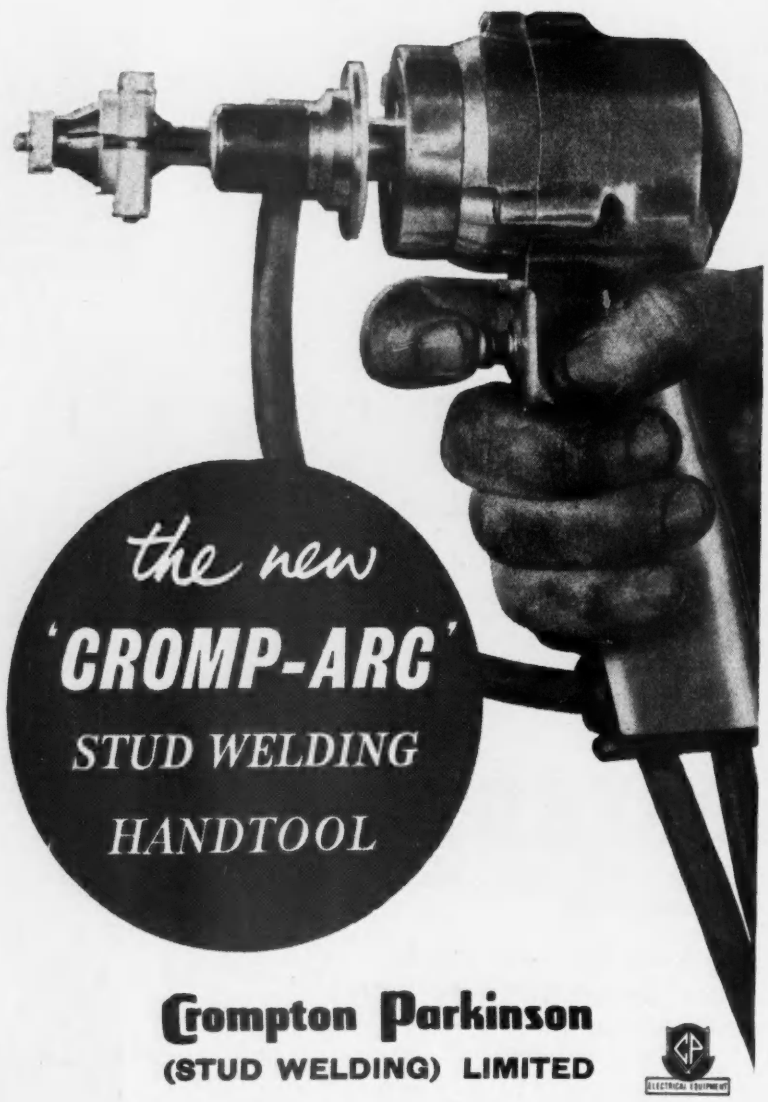
The Crompton Parkinson Stud Welding Organisation is at your service. Technical representatives are ready to discuss without obligation how this new equipment might solve some of your manufacturing problems.



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STUD WELDING HANDTOOL

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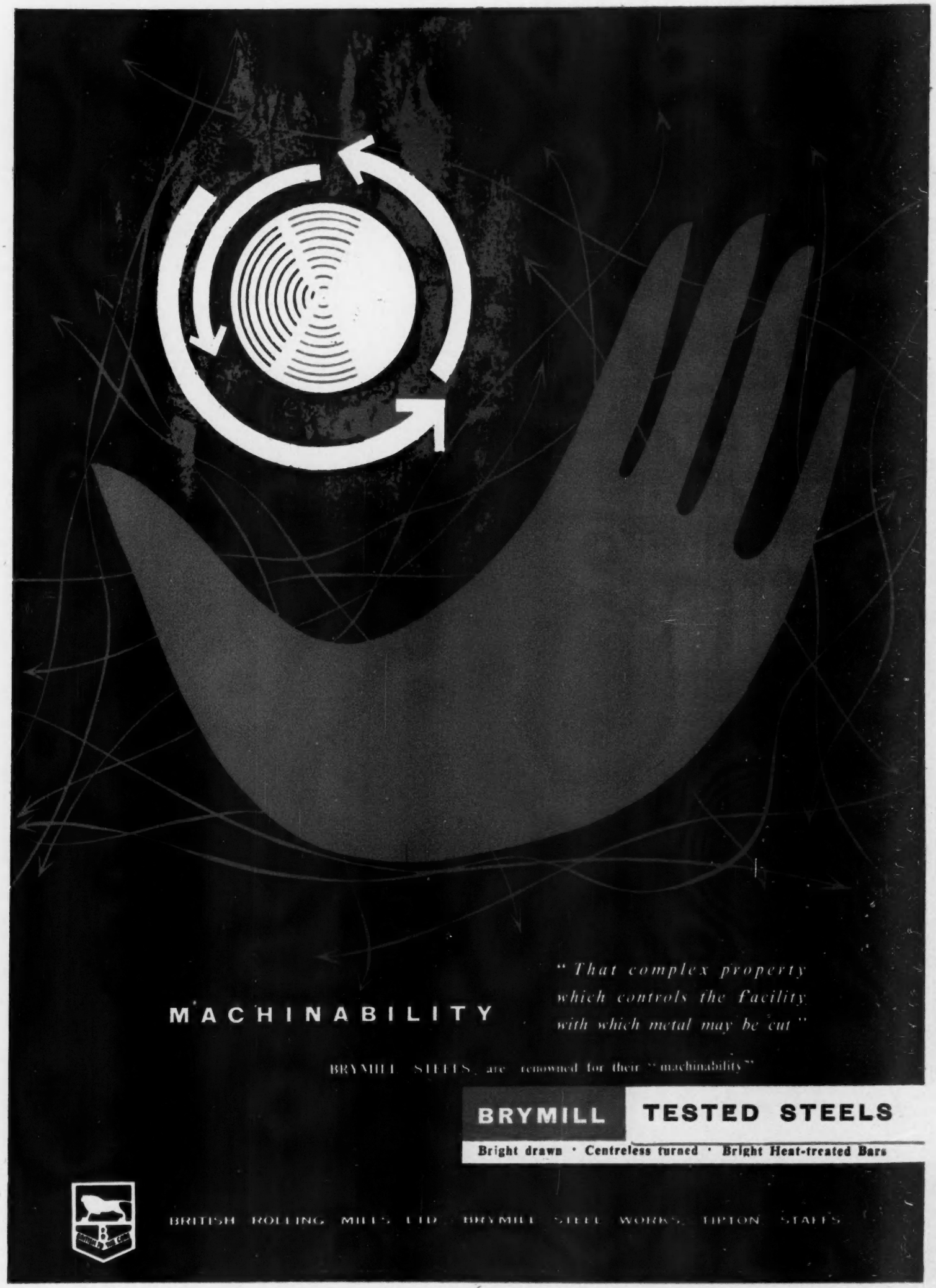

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200 TONS OF FILTER STEEL-WORK ERECTED AT THE TOP OF EACH OF TWO PILE CHIMNEYS 414 FEET HIGH

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Photograph of one of the Pile Buildings & Blower Houses at Windscale Works, Sellafield, Cumberland.
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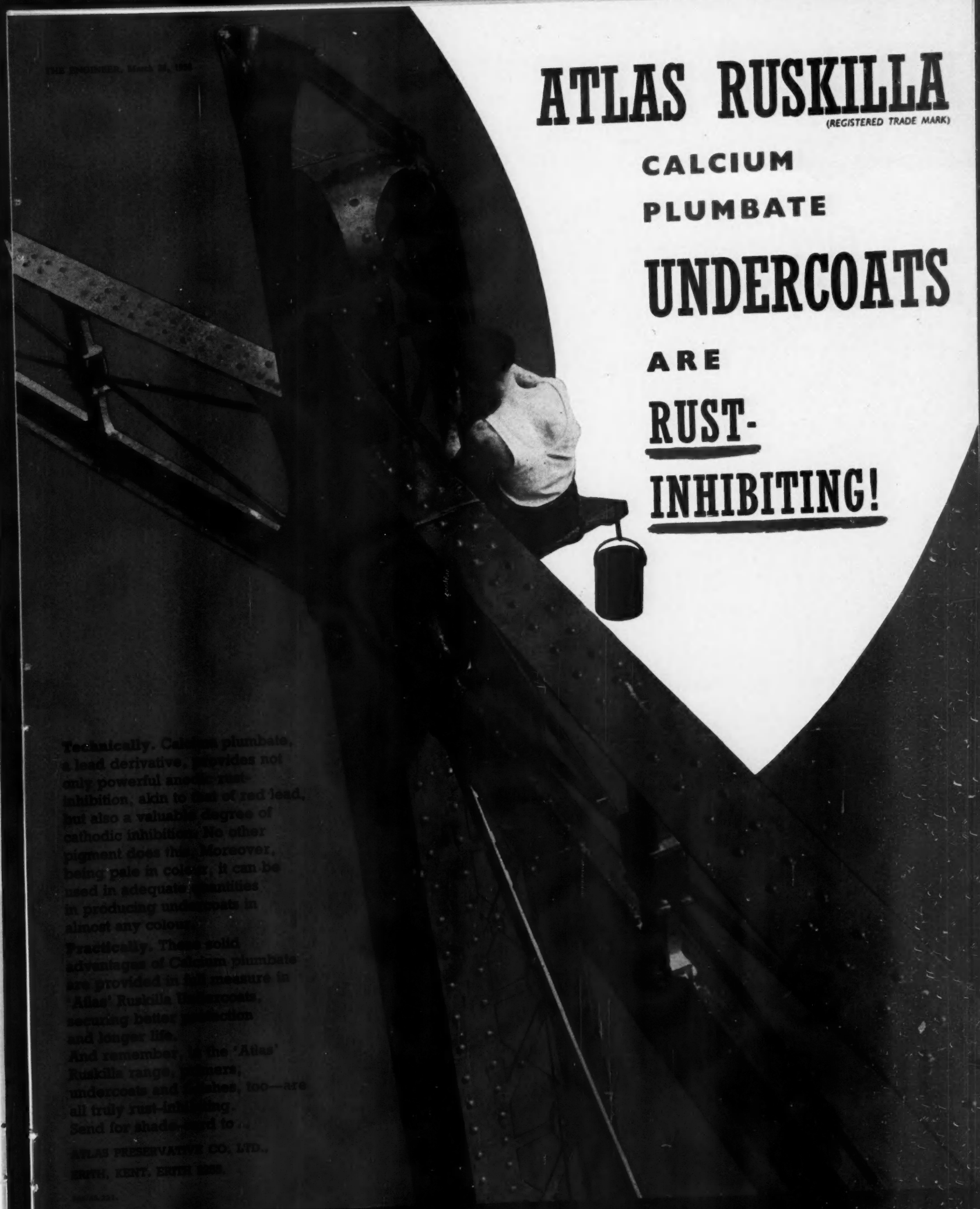
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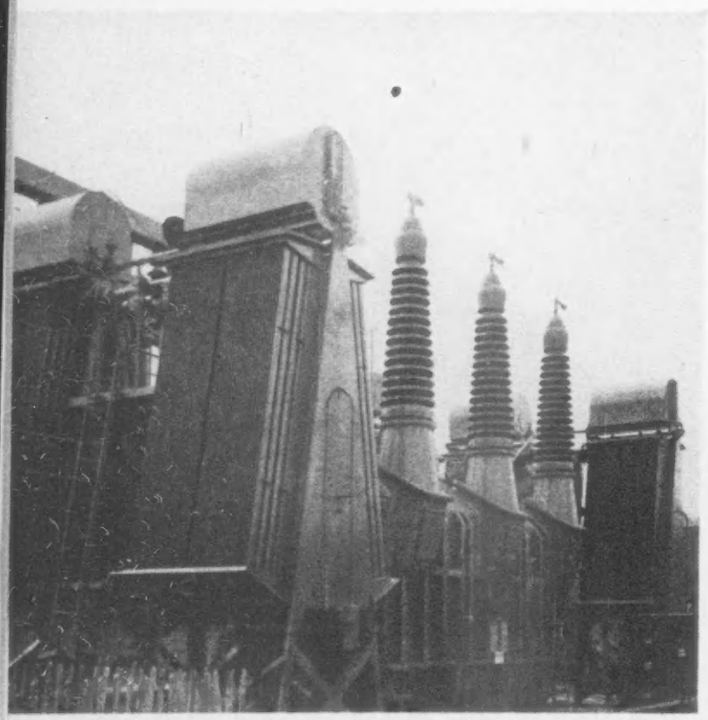

The first of three Parsons 120 MVA 3-phase auto-transformers en route to the C.E.G.B. North Western Division, Harker substation near Carlisle. Each of these transformers has a voltage ratio of 275/132 kV, voltage variations being achieved by on-load tap changing gear. In transit the transformer weighs 127.5 tons. On site, complete, including oil, 239 tons.

Several Parsons 120 MVA transformers are already in operation with C.E.G.B. on 132 kV and 275 kV grid systems.

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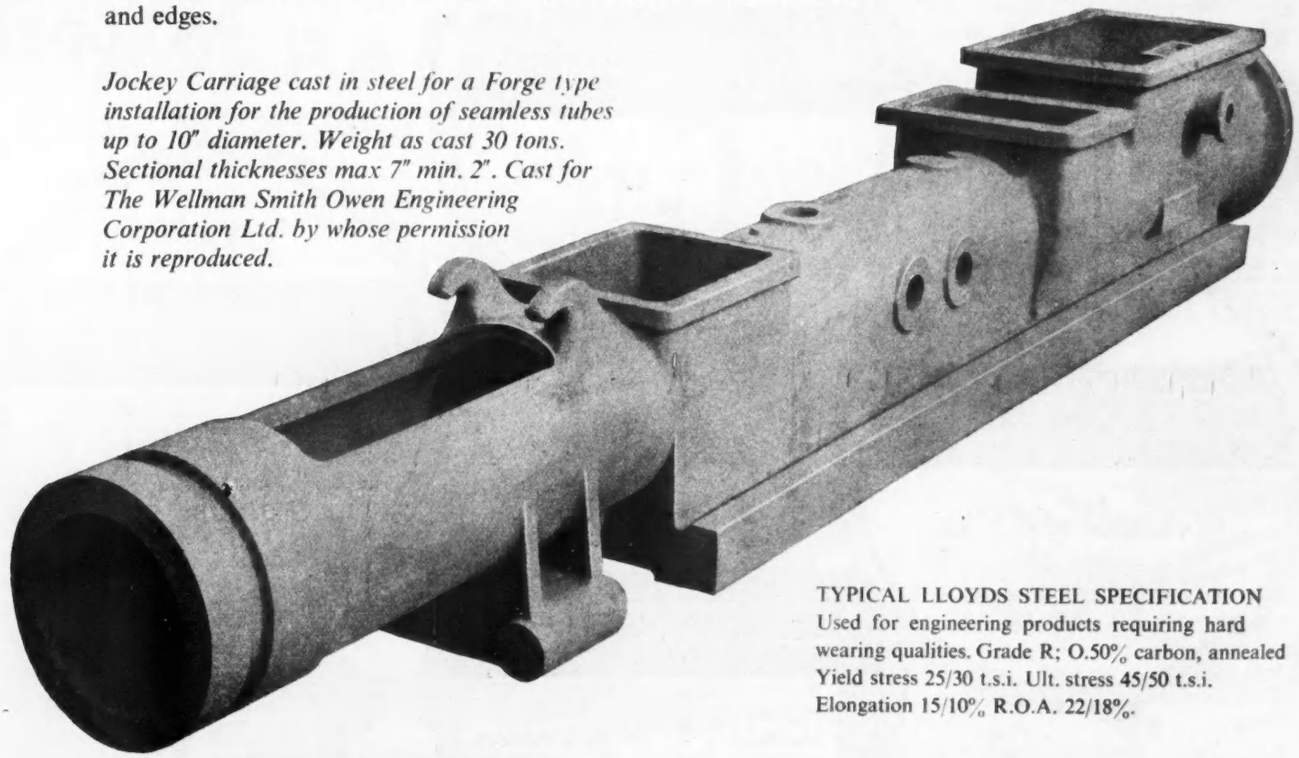
TRANSFORMERS

C. A. PARSONS & COMPANY LIMITED · HEATON WORKS · NEWCASTLE UPON TYNE 6

cast for a "shockable" part

This jockey carriage is cast in steel for a forge type of installation for the production of seamless tubes up to 10″ diameter, and has to withstand unpredictable shock load. It is a good example of the versatility of steel casting, in that its sectional thickness varies from 2″ to 7″, essential requirements that make it almost impossible to fabricate by any other method.
Owing to good method planning this casting is free from defects and of especial interest is the fine finish. Note also the sectional thickness round the corners and edges.



Jockey Carriage cast in steel for a Forge type installation for the production of seamless tubes up to 10″ diameter. Weight as cast 30 tons. Sectional thicknesses max 7″ min. 2″. Cast for The Wellman Smith Owen Engineering Corporation Ltd. by whose permission it is reproduced.

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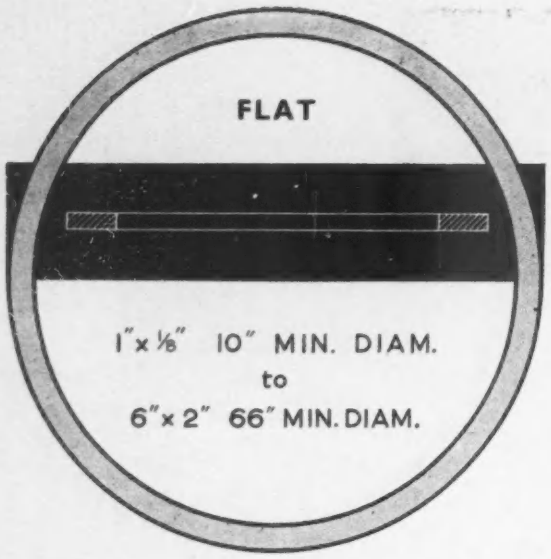

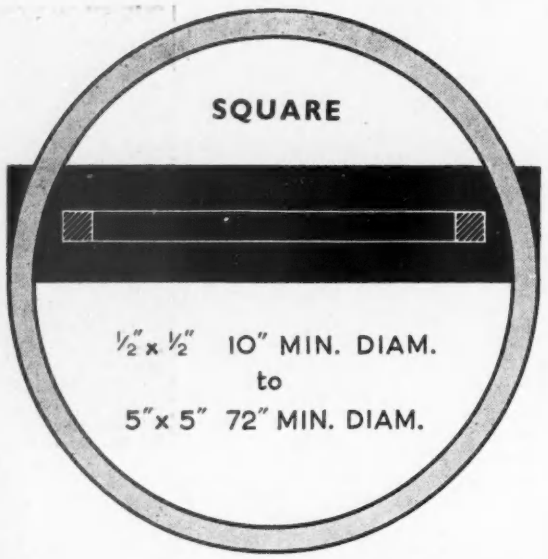

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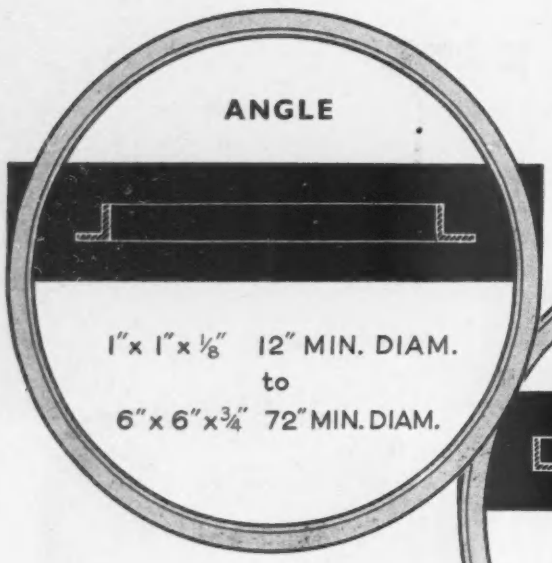

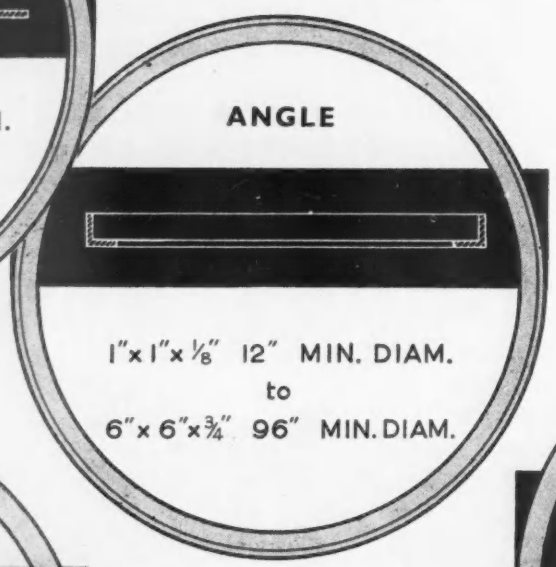

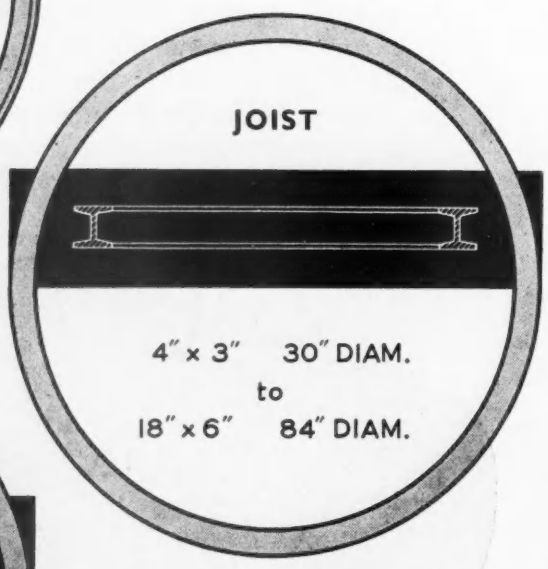

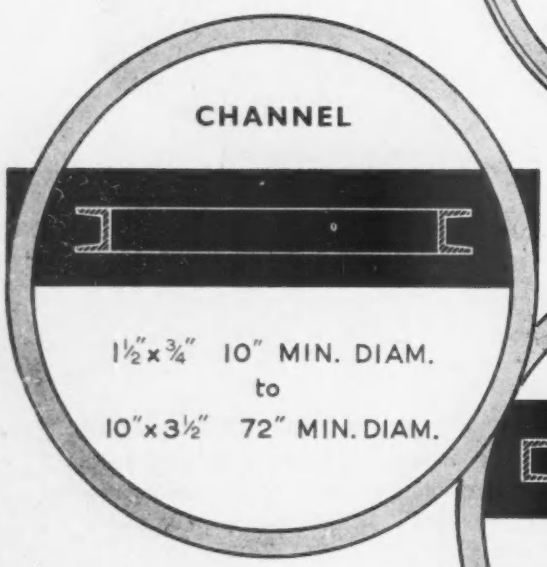

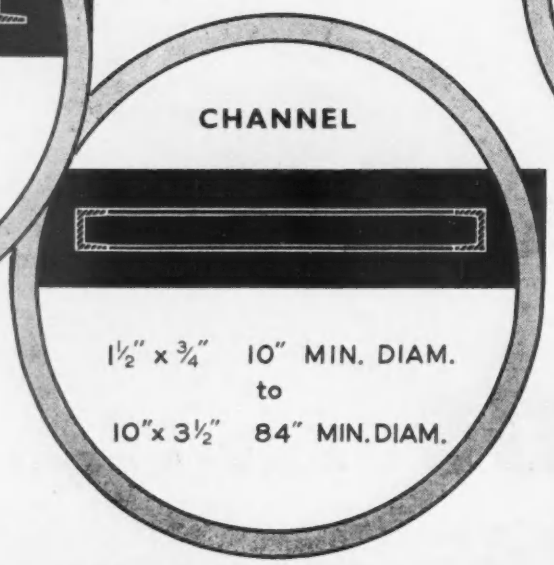

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- **CUTS HOLES OF ANY SHAPE IN HARDENED MATERIAL, CARBIDES ETC.**

. . . in fact any material through which electric current can pass.

The new MARBAIX M.58 disintegrator removes broken taps, drills, reamers, studs, etc., in a fraction of normal time, without damage to the component.
Holes, too, of any shape can be cut in hardened material, for subsequent finishing by grinding or other methods. Note the times for the various examples shown, and write today for full details to DEPT. E.1.

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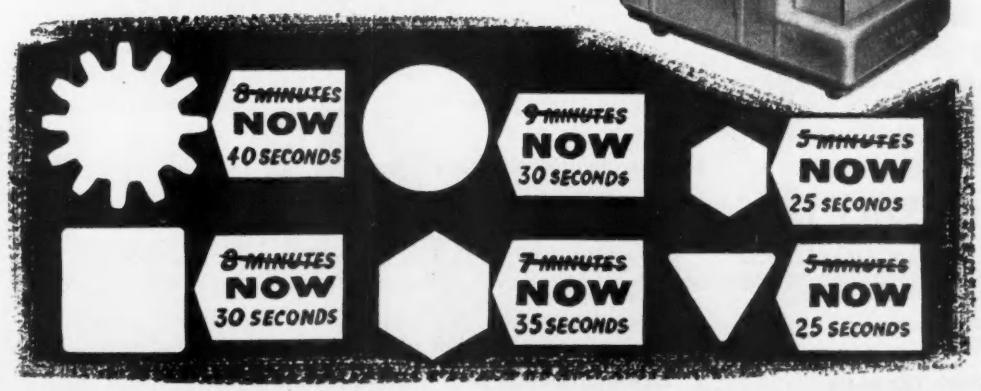
Times obtained on Model M58-C (as illustrated)


8 MINUTES NOW 40 SECONDS
9 MINUTES NOW 30 SECONDS
5 MINUTES NOW 25 SECONDS
8 MINUTES NOW 30 SECONDS
7 MINUTES NOW 35 SECONDS
5 MINUTES NOW 25 SECONDS

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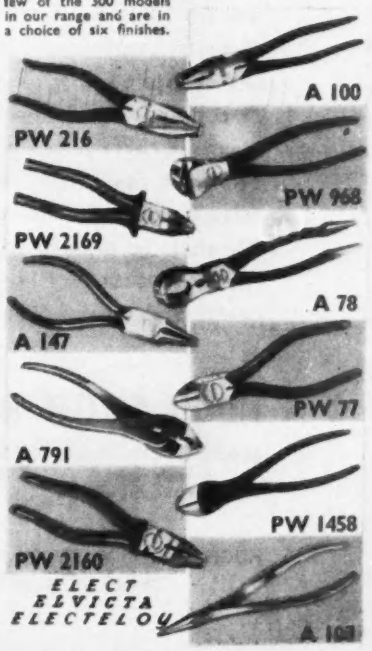

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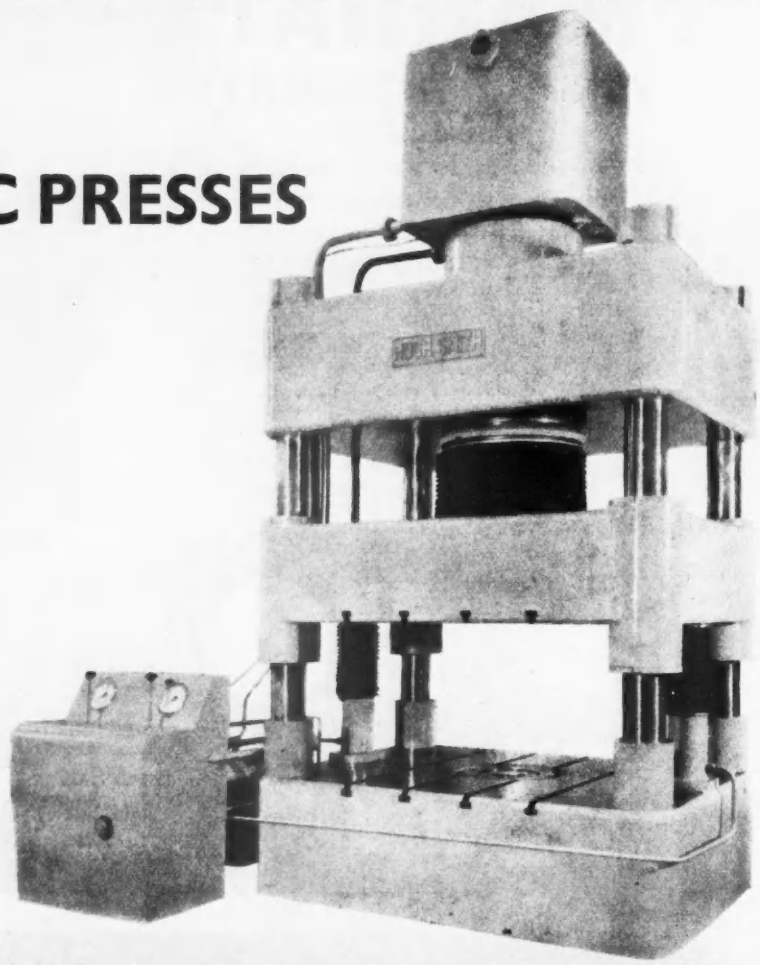

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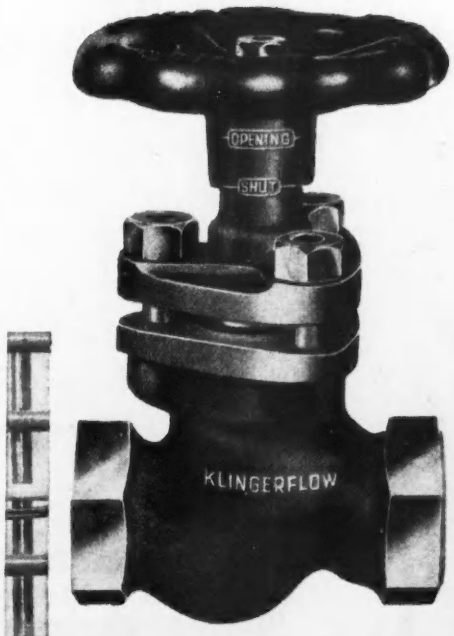
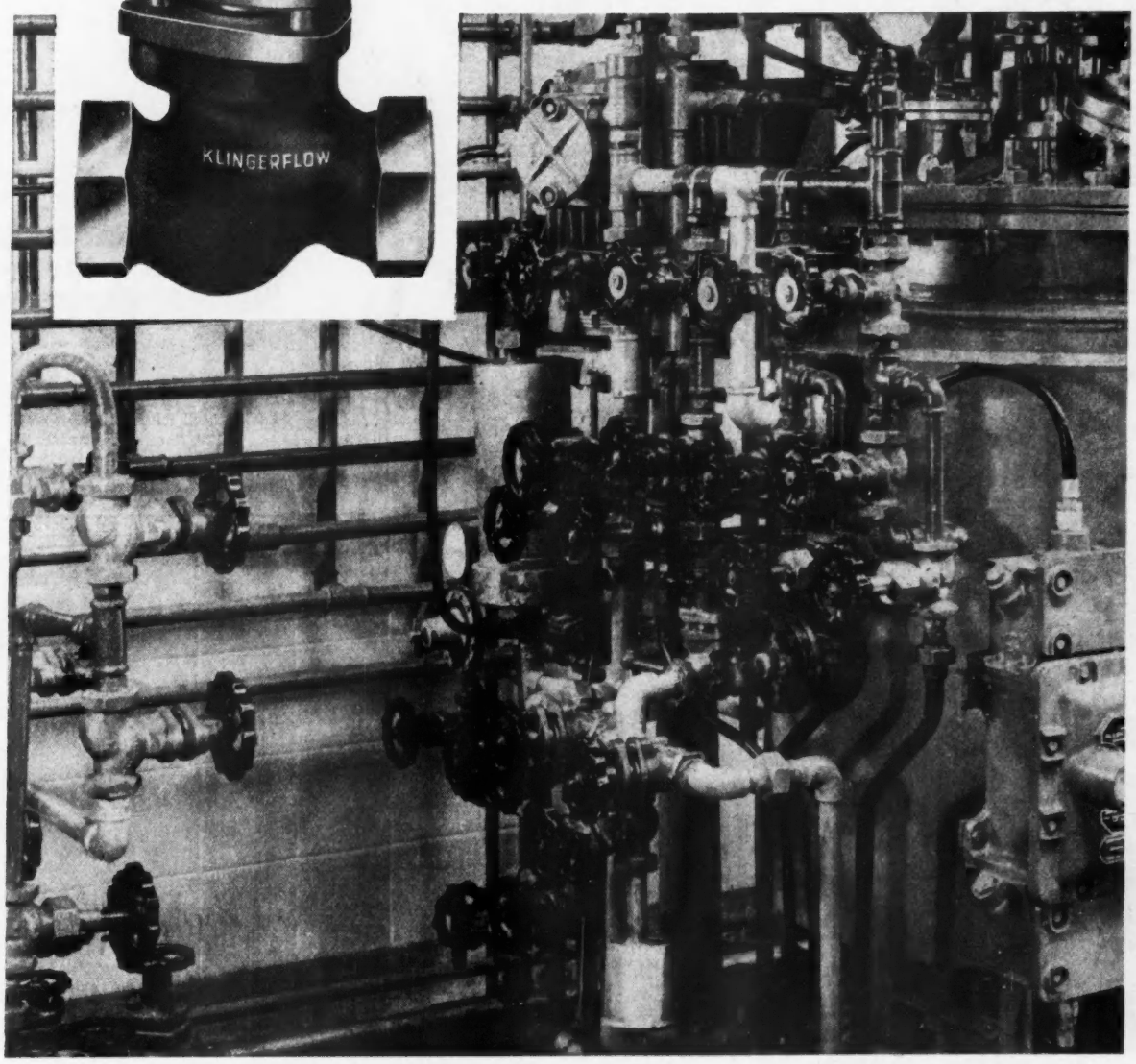


Klinger

PISTON TYPE VALVES



THE photograph shows a small part of the Fermentation plant at the Beecham Research Laboratories at Betchworth, where microbial substances are produced. All the valves visible in the picture and throughout the plant are Klinger Piston Valves. Klinger Sleeve-packed Cocks are also installed. The fluids controlled by valves include steam, hot and cold water, brine and compressed air.

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G37/58/V

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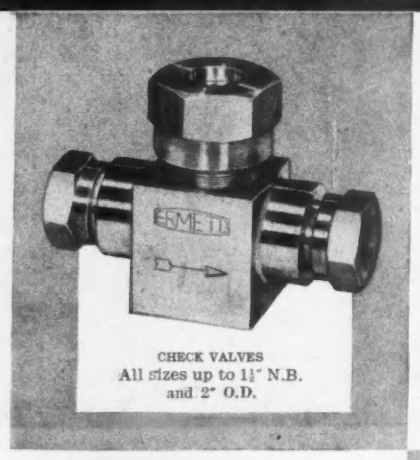
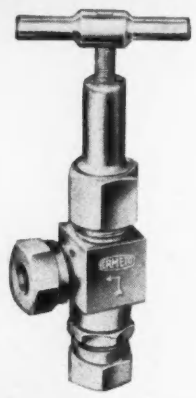
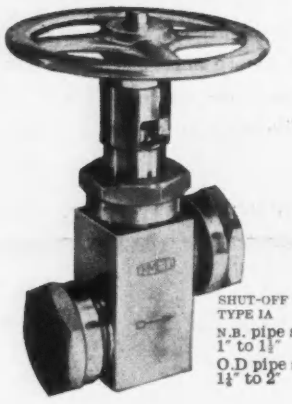


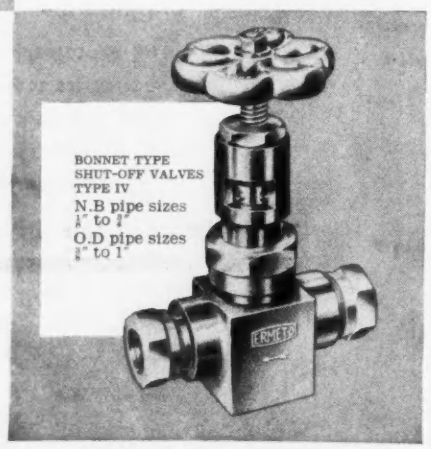
CHECK VALVES
All sizes up to 1¼" N.B. and 2" O.D.



FINE CONTROL VALVES TYPE III
N.B pipe sizes ⅛" to ¾"
O.D pipe sizes ¼" to 1"



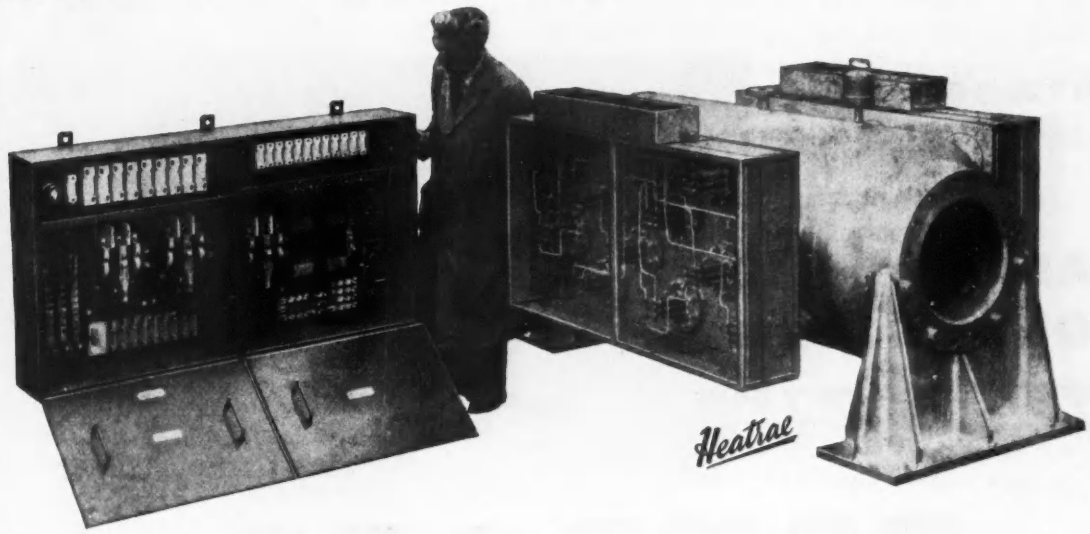
SHUT-OFF VALVES TYPE IA
N.B. pipe sizes 1" to 1½"
O.D pipe sizes 1¼" to 2"



BONNET TYPE SHUT-OFF VALVES TYPE IV
N.B pipe sizes ⅛" to ¾"
O.D pipe sizes ⅛" to 1"

Heatrae

ELECTRIC AIR HEATERS



Made in rectangular form for low pressures or cylindrical for higher pressures. Fig. 1 shows a 150 kW Air Heater with Control Panel; working pressure 150 lbs p.s.i., Temperature 650°F.

Please ask for catalogue Section CAE, Pages 3 and 4.

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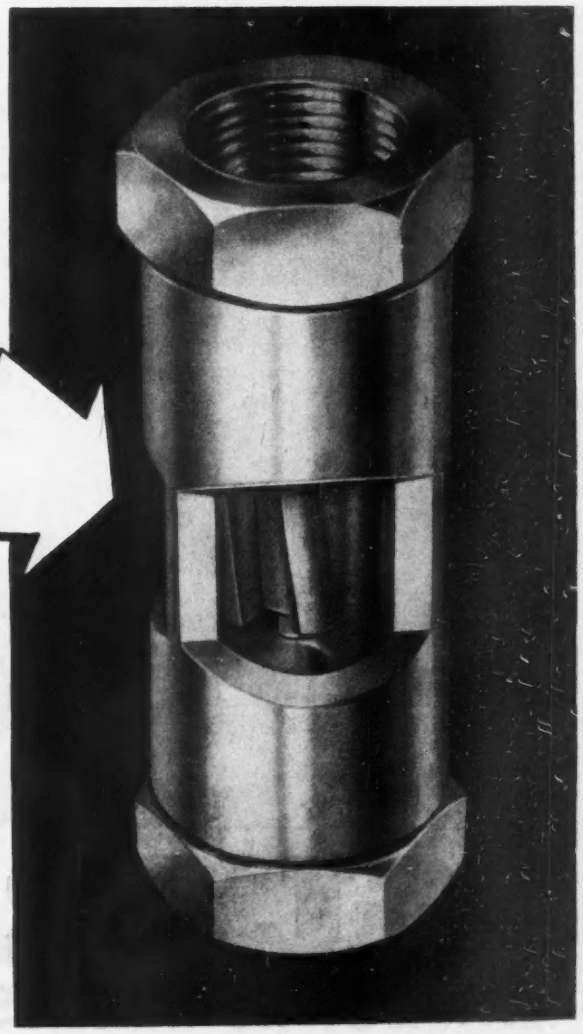
- *Extreme sensitivity at all pressures.*
- *Units readily adaptable to existing installations.*
- *May be mounted in any plane.*
- *Comparative flow gauged by speed of revolving rotor.*



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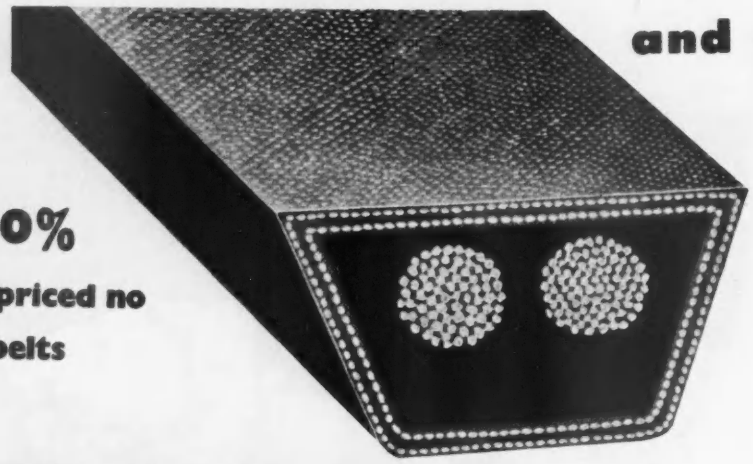
between this  and any other V-belt

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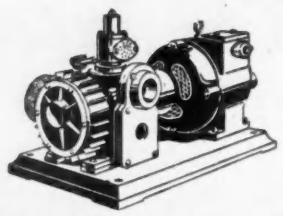

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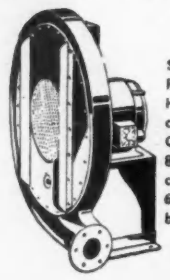

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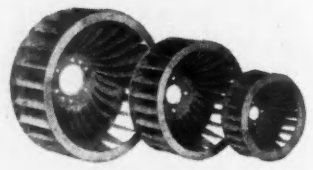

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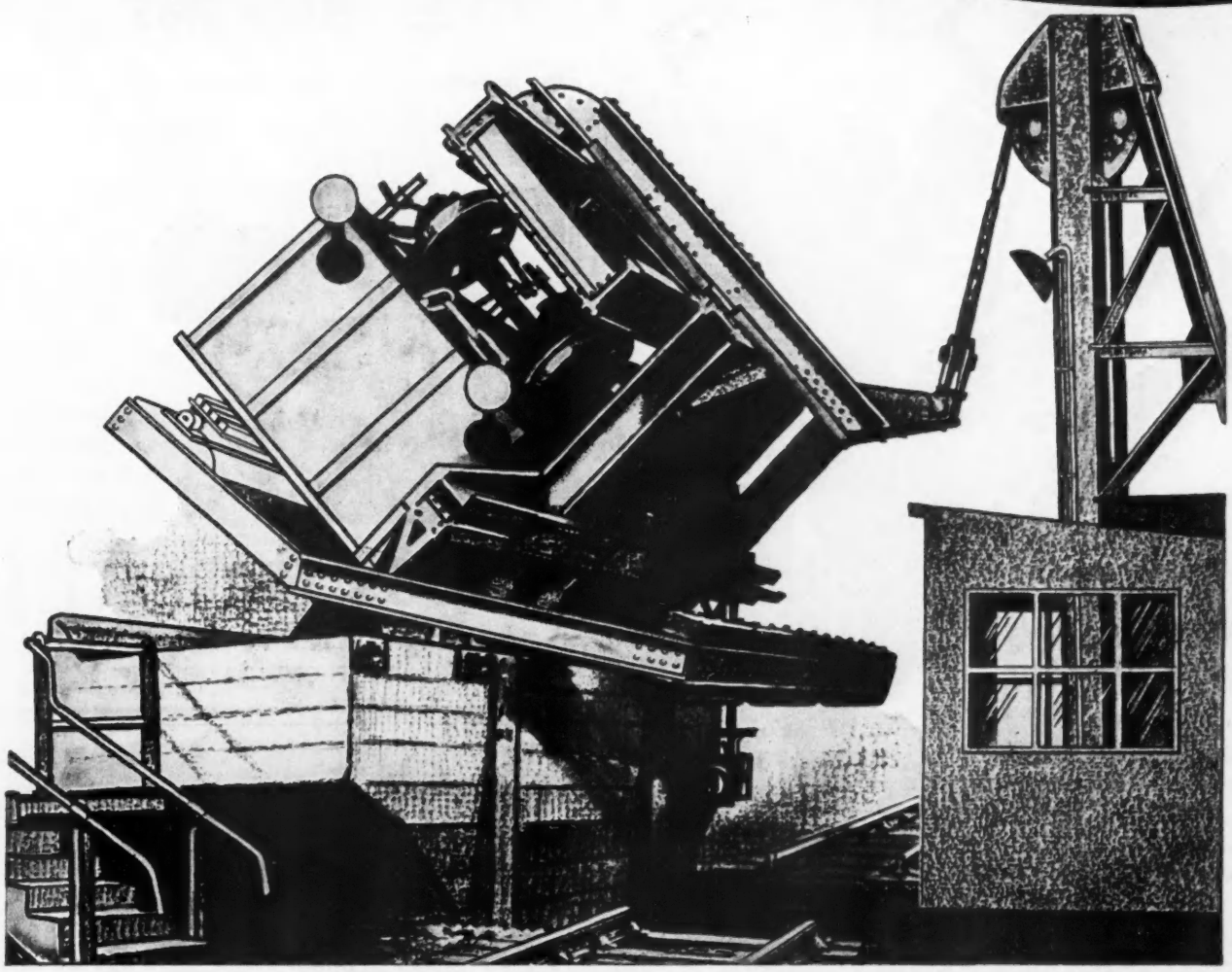

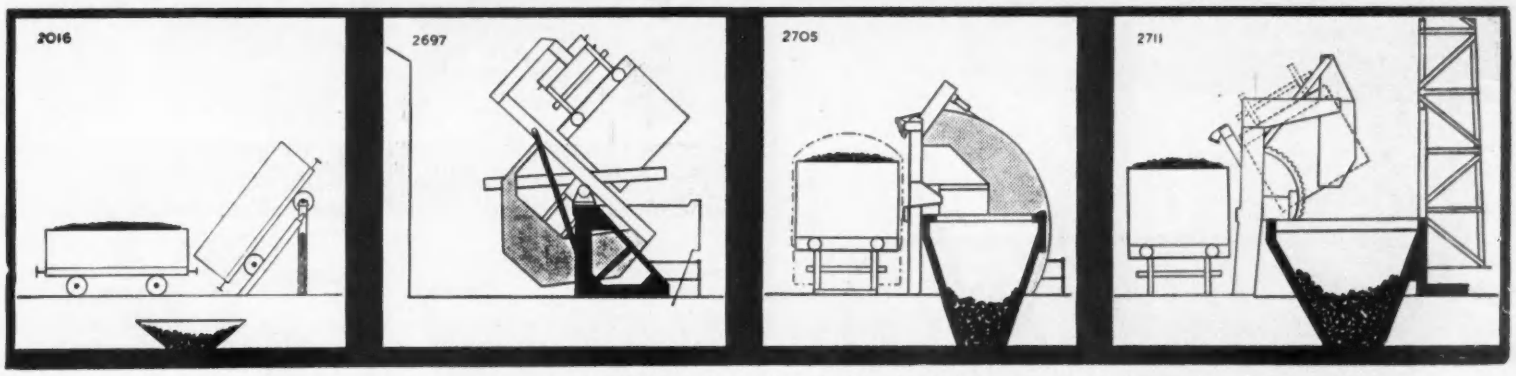

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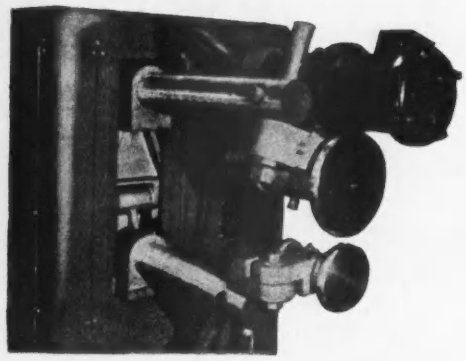

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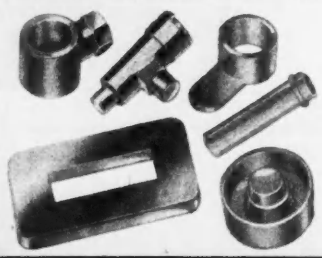

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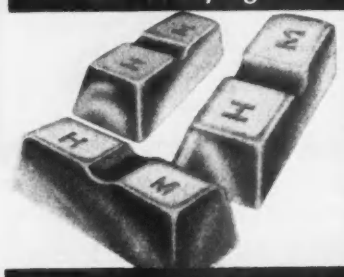

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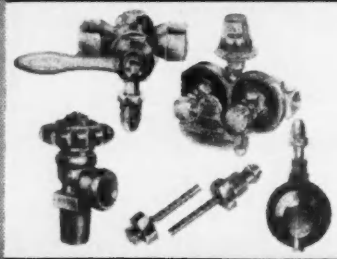

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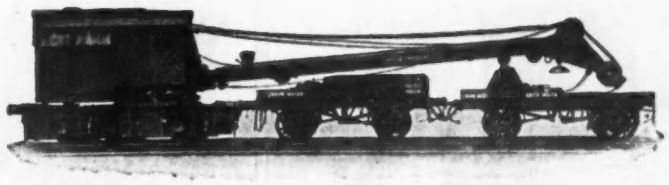

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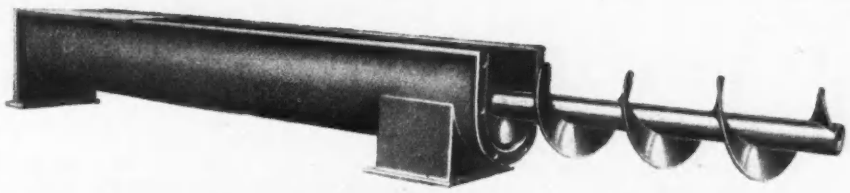

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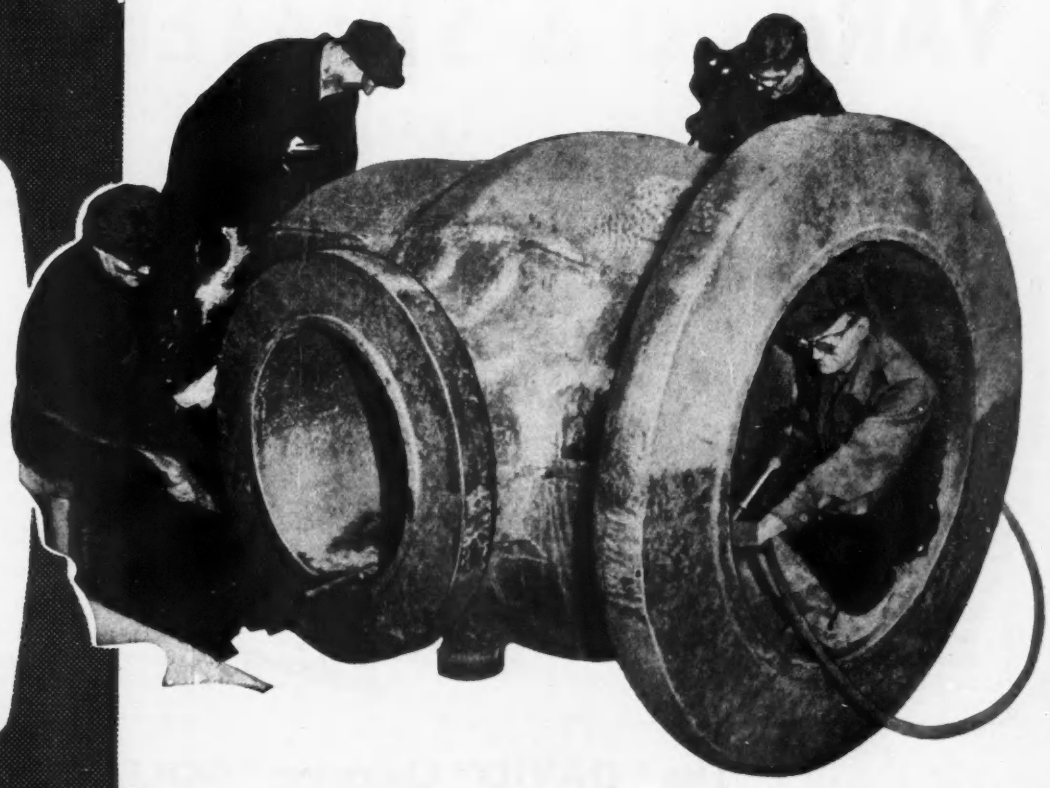

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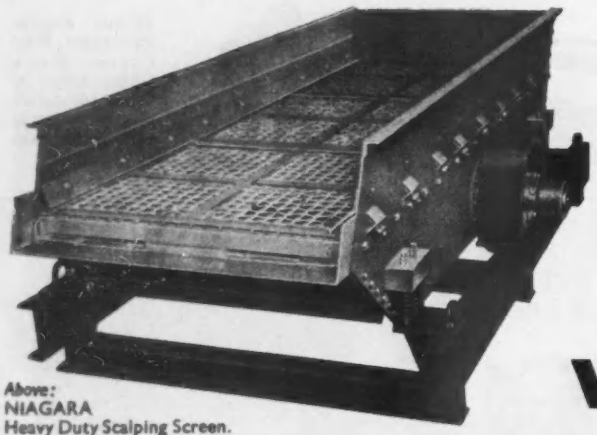

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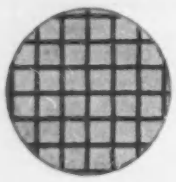

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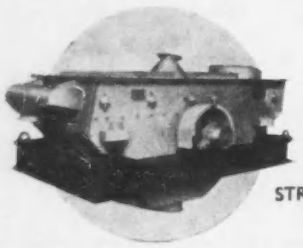

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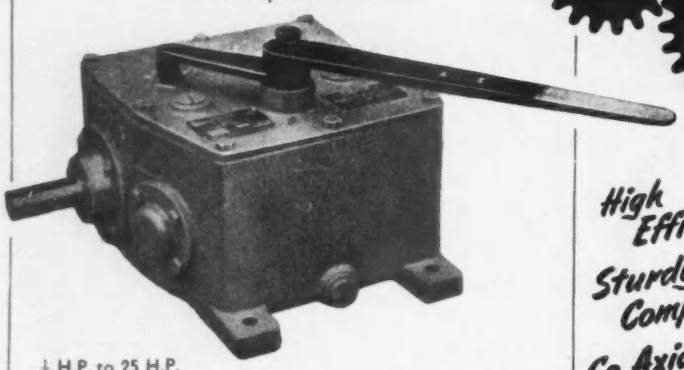

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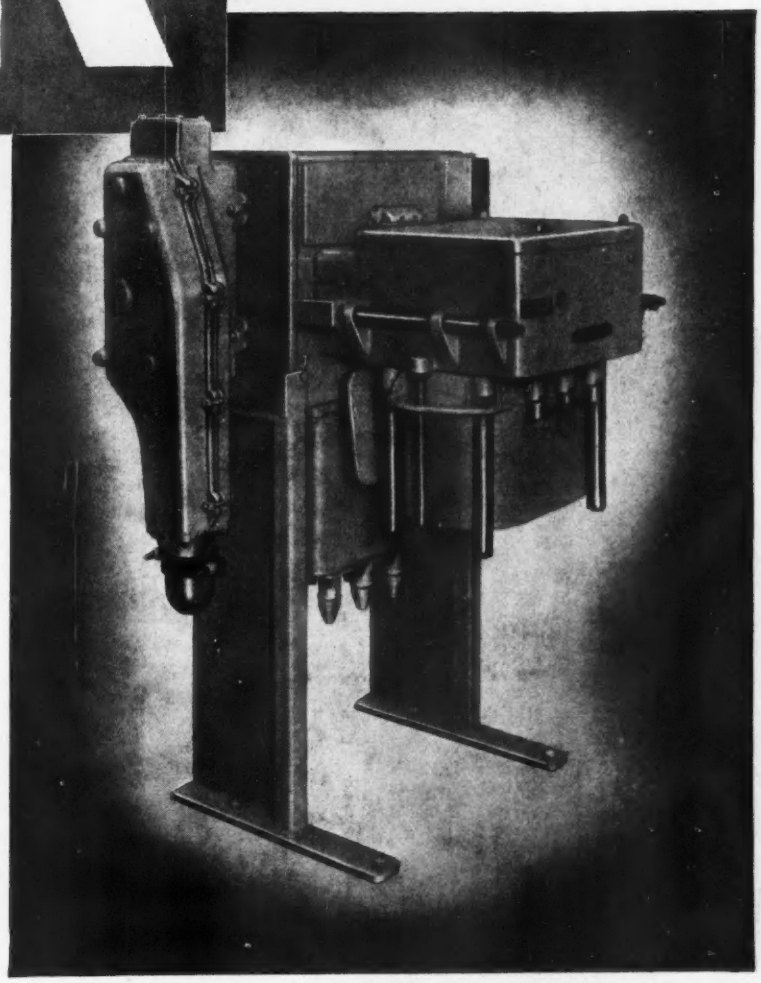

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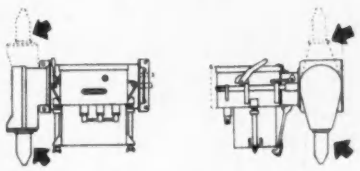
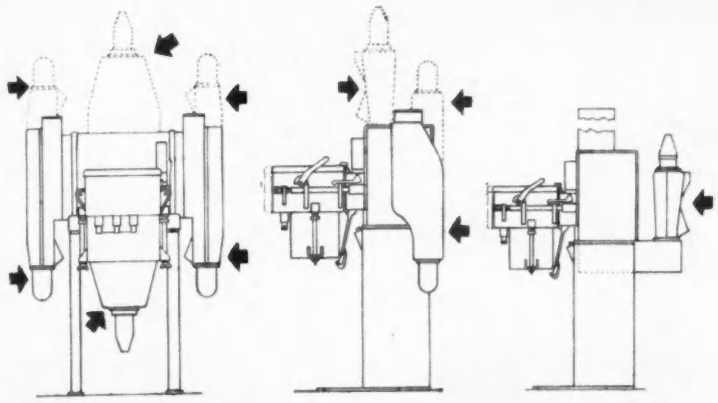


Wall mounted type



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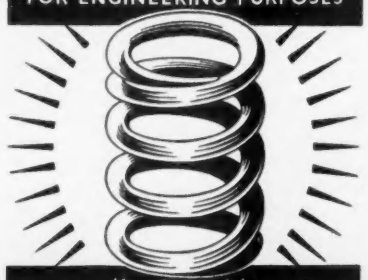

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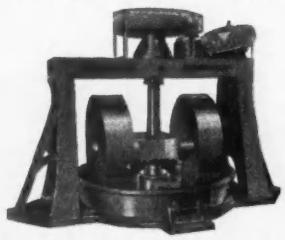

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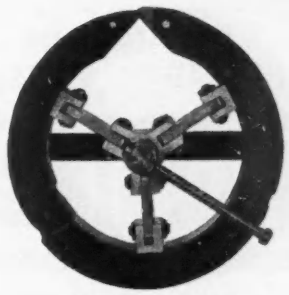

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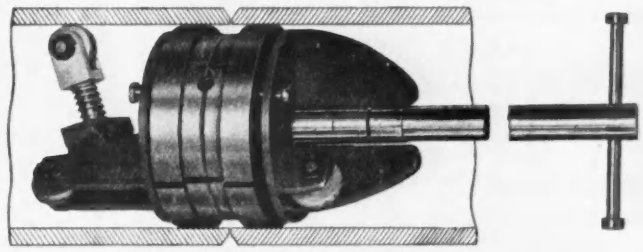

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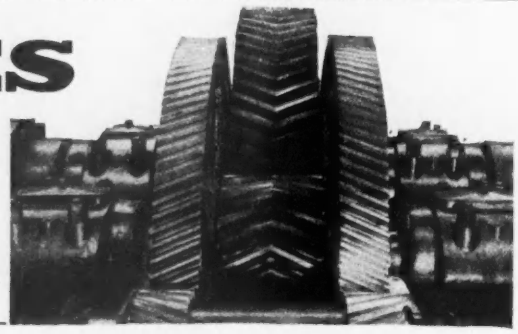

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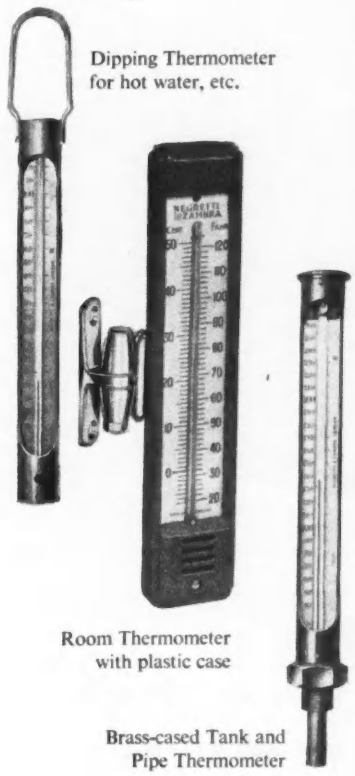
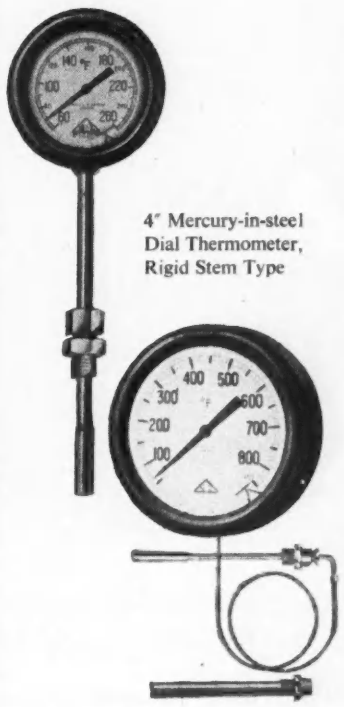


Dipping Thermometer
for hot water, etc.

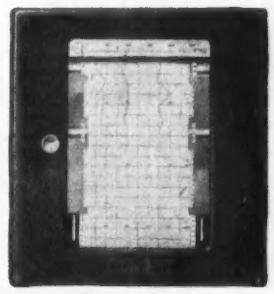
Room Thermometer
with plastic case

Brass-cased Tank and
Pipe Thermometer

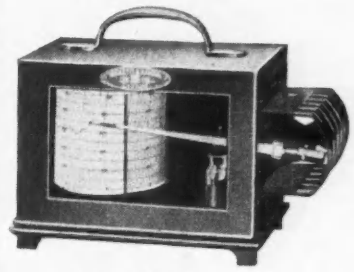


4" Mercury-in-steel
Dial Thermometer,
Rigid Stem Type

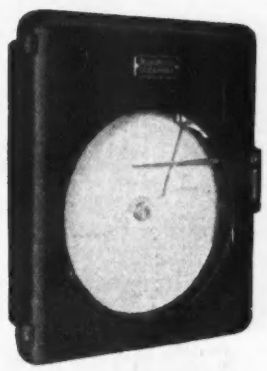
Distance-type Mercury-in-
steel Dial Thermometer



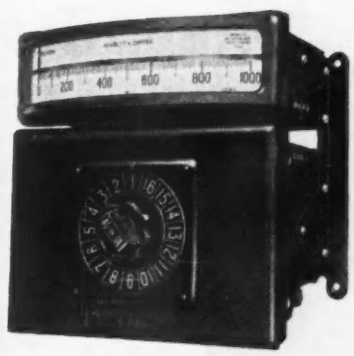
Resistance Thermometer
Recorder



Bi-metallic Recording
Thermometer



Mercury-in-steel Disc
Chart Recorder



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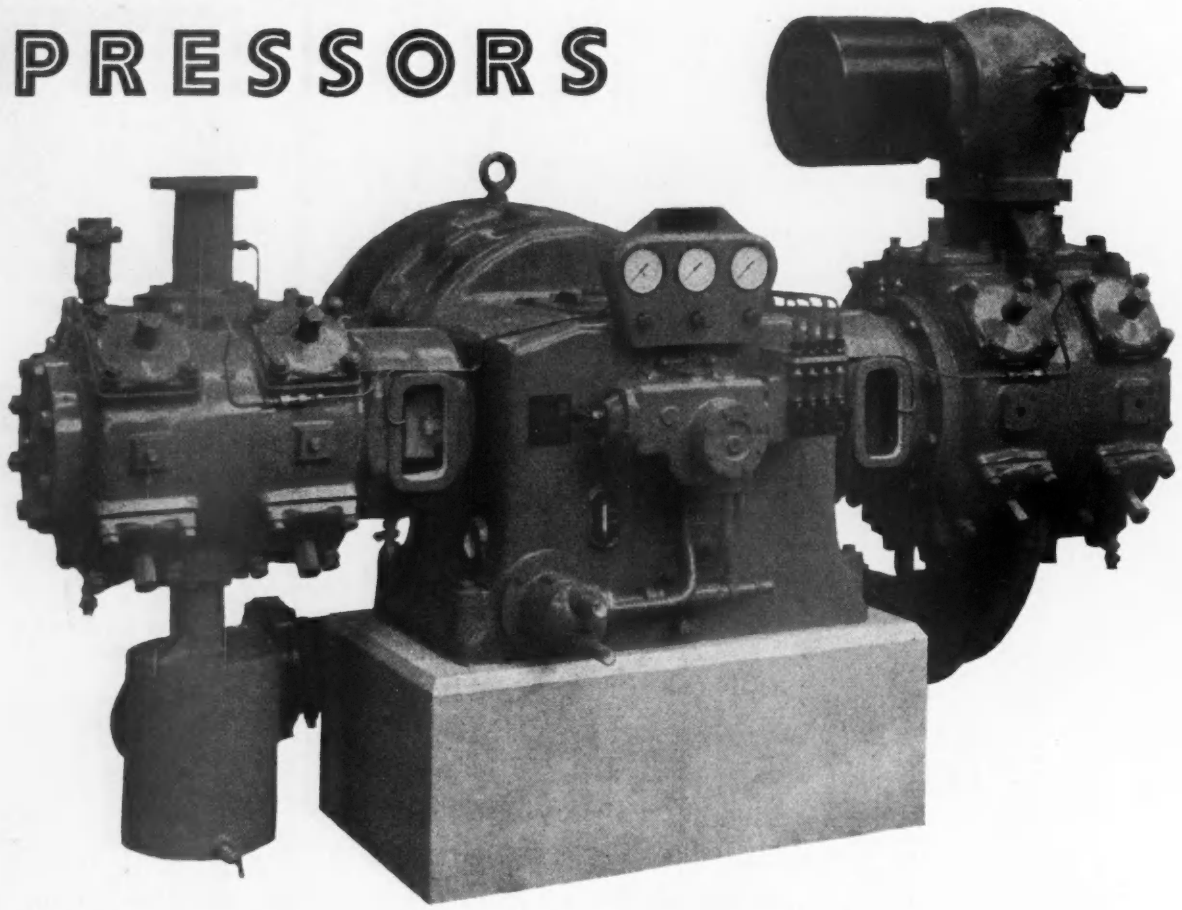
Nottingham. Agents or subsidiaries in most countries.

ALLEY

BALANCED OPPOSED COMPRESSORS



The long established high quality of Alley Compressors is combined in these machines with the known advantages of the horizontally-opposed design.

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BALANCE: No horizontal or vertical out-of-balance forces.

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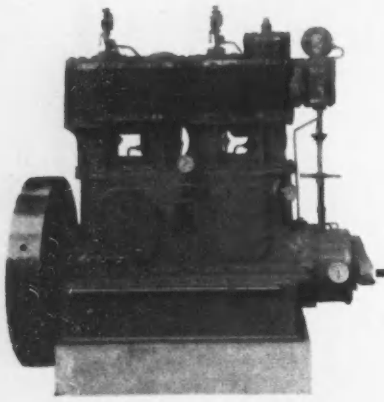
Can be installed on a minimum foundation—even on an upper floor.

The unit is complete—intercooler and oilcooler incorporated—ready for bolting down.

Range of single and two stage machines from 400 to 2000 c.f.m.

A corresponding range of VACUUM PUMPS is available with displacements up to 3,000 c.f.m.



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Licensed to manufacture Gas Compressors to the designs of Clark Bros. Co., Olean, U.S.A.

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CLASSIFIED ADVERTISEMENTS

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Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

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Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/-, which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:— **Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF SOUTHEND-ON-SEA

EDUCATION COMMITTEE

MUNICIPAL COLLEGE

Principal:
T. L. MORGAN, M.Sc., A.M.I.C.E., A.M.I.Struct.E.

APPOINTMENTS

Applications are invited for the following posts:—
(i) LECTURER, Electronic Engineering and Engineering Physics. Salary £1200 by £30 to £1350.
(ii) ASSISTANT GRADE B, Radio Service Work, including Television. Salary £650 by £25 to £1025, with additions for training, graduation and good Honours Degree.

Further particulars and forms of application may be obtained from the undersigned (stamped addressed, foolscap envelope).

Completed forms should be returned to the Principal, Municipal College, Victoria Circus, Southend-on-Sea, within fourteen days of the appearance of this advertisement.

D. B. BARTLETT,
Chief Education Officer.

Education Office,
Warrior Square,
Southend-on-Sea. E6531

ESSEX EDUCATION COMMITTEE

SOUTH-WEST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART
FOREST ROAD, WALTHAMSTOW, E.17

LECTURER

Required, as soon as possible, LECTURER IN MECHANICAL ENGINEERING, to teach Mechanics of Fluids and Applied Thermodynamics or Mechanics of Machines.

The College provides courses leading to B.Sc. (Eng.) and Higher National Certificate. Applicants should be Graduates and/or Associate Members of the Institution of Mechanical Engineers. Some teaching and industrial experience is desirable.

Salary: £1200 by £30 to £1350, plus London allowance (£36 or £48).

Applications (no forms), giving particulars of qualifications, training and experience, should be submitted to the Clerk to the Governors at the College. E6582

WORCESTERSHIRE EDUCATION COMMITTEE

COLLEGE OF FURTHER EDUCATION, BROMSGROVE

APPOINTMENTS

Due to expansion consequent upon entering the new college, in session 1958/59, the following additional appointments are to be made.
(1) LECTURER IN THERMODYNAMICS. Applicants should be University Graduates or equivalent, with industrial and/or teaching experience. Salary, £1200 by £30 to £1350.
(2) ASSISTANT, Grade B. Mechanical Engineering, for Ordinary National Diploma and Certificate Courses. £650 by £25 to £1025.

Particulars of the above posts and application forms may be obtained from the Chief Education Officer (S/J), County Education Office, Castle Street, Worcester, on receipt of stamped, addressed foolscap envelope. E6571

UNIVERSITY OF BIRMINGHAM

LECTURESHIP IN METALLURGY

Applications are invited for a LECTURESHIP IN METALLURGY. Candidates should have a suitable Degree and industrial or research experience. The work involves lectures to final-year and post-graduate students, and good opportunities exist for research. Salary within range £900–£1650 per annum with F.S.S.U. and family allowances.

Applications (two copies), with the names of three referees, should be sent to the Deputy Registrar, The University, Birmingham, 15, from whom further particulars may be obtained. E6552

PUBLIC APPOINTMENTS

MONMOUTHSHIRE EDUCATION COMMITTEE

THE TECHNICAL COLLEGE OF MONMOUTHSHIRE, CRUMLIN

Principal: Dr. T. V. STARKEY, F.Inst.P.

LECTURER IN MECHANICAL ENGINEERING

LECTURER IN MECHANICAL ENGINEERING is required for the 1st of September next. Candidates must hold a Degree or equivalent qualification in Mechanical Engineering and have had suitable industrial experience. Teaching or research experience would be regarded as added qualifications.

The salary for this post is £1200 per annum by £30 to £1350 per annum.

Further particulars and forms of application can be obtained from the undersigned, to whom completed forms should be returned as soon as possible.

T. M. MORGAN,
Director of Education.

County Hall,
Newport, Mon. E6570

COUNTY OF LEICESTER

COALVILLE MINING AND TECHNICAL COLLEGE

Principal: W. A. BURROWS, B.Sc.

ASSISTANT GRADE "A"

Required, for September, 1958, ASSISTANT GRADE "A," to teach General Engineering subjects. Salary £475 by £25 to £900, plus appropriate allowances for Degrees, training and industrial experience.

Applications (no forms), together with details of qualifications, age, education, industrial and teaching experience, together with copies of two recent testimonials and names of three referees, should be sent to the Principal, Mining and Technical College, Bridge Road, Coalville, by 11th April, 1958. E6581

BUCKINGHAMSHIRE EDUCATION COMMITTEE

SLOUGH COLLEGE OF FURTHER EDUCATION
(Principal: R. EDGAR, M.Sc., M.A.)

LECTURER

Applications are invited for the post of LECTURER IN PRODUCTION ENGINEERING, with effect from 1st September, 1958. The person appointed will be required to teach up to H.N.C. level in Mechanical and Production Engineering courses (with special reference to jig and tool design and machine tools), and to assist with City and Guilds courses. Teaching and industrial experience essential.

Salary will be paid in accordance with the appropriate Burnham Report, i.e. £1200 by £30 to £1350 per annum.

Forms of application and further particulars may be obtained from the Principal, College of Further Education, William Street, Slough, to whom completed forms should be returned within fourteen days of the date of the appearance of this advertisement. E6530

COUNTY OF LEICESTER

COALVILLE MINING AND TECHNICAL COLLEGE

Principal: W. A. BURROWS, B.Sc.

LECTURER IN ENGINEERING

Applications are invited for the following additional post, commencing September, 1958:—

LECTURER IN ENGINEERING, with sound workshop experience. Salary £1200 by £30 to £1350.

Applications (no forms), together with details of qualifications, age, education, industrial and teaching experience, copies of two recent testimonials, and names of three referees, should be sent to the Principal, Mining and Technical College, Bridge Road, Coalville, by 11th April, 1958. E6583

PUBLIC APPOINTMENTS

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE UPON TYNE

LECTURESHIP IN MECHANICAL ENGINEERING

The Council of King's College invite applications for a LECTURESHIP IN MECHANICAL ENGINEERING.

Applicants should hold a good Degree or its equivalent in Engineering and have had some professional experience since graduation. Preference will be given to candidates with an interest in the teaching of engineering design. The Lecturer will also be required to take some part in the teaching of other branches of mechanical engineering and will have opportunities for doing research work for a higher Degree.

The salary scale rises by annual increments of £50 to a maximum of £1650 and the commencing salary will be fixed at a suitable point on the scale, in accordance with the qualifications and experience of the successful applicant. Family allowance and F.S.S.U.

Twelve copies of application, together with the names of three persons to whom reference may be made, should be submitted not later than 21st April to the undersigned, from whom further particulars may be obtained.

G. R. HANSON,
E6586 Registrar of King's College.

ROYAL NAVAL SCIENTIFIC SERVICE

APPOINTMENTS

Royal Naval Scientific Service requires PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS for 25 Senior Scientific and Scientific Officer posts at establishments in London area, Baldock, Harwell, Haslemere, Poole, Greenock and Rosyth. Also required: MECHANICAL ENGINEER for work on heat transfer problems at Harwell; MECHANICAL ENGINEER for work on fuel and lubricating oil problems in London area; MECHANICAL ENGINEER for work on gas turbine and problems in London area; CHEMICAL ENGINEERS for London area and Poole; METALLURGISTS for Rosyth and Poole; CHEMISTS (Physical and Inorganic) for Poole and Baldock. Candidates must normally be natural born British subjects of natural born British parents, with at least First or Second Class Honours Degrees or equivalent high professional attainments. S.S.O.s must have had at least three years' post-graduate experience and be 26 years of age. Salaries (men), S.S.O., £1190–£1410; S.O., £635–£1110 (London)—somewhat lower in provinces. Appointments are unestablished (with F.S.S.U. benefits), but opportunities may occur for those under 32 to compete for established posts.—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A.98/8A. E6550

THE REPUBLIC OF THE SUDAN

SENIOR MECHANICAL ENGINEER

The Equitoria Projects Board has a vacancy for a SENIOR MECHANICAL ENGINEER at Nzara, Equatoria Province, Sudan.

The successful candidate will be required to take charge of all mechanical engineering services of the Board, which comprises spinning and weaving mill, ginning factory and oil mill, together with workshops, power stations and a transport department. This has its own engineer in charge responsible to the Senior Mechanical Engineer.

Applicants should be between 30–45 years of age, with professional qualifications leading to Corporate Membership of the Institution of Mechanical Engineers. Should have wide workshop and general engineering experience in factory machinery, steam boilers, oil engines and power installations.

Appointment will be on a short-term contract for a period of three years, in the salary range £S1200 to £S1750. Point of entry will be fixed in accordance with age, qualifications and experience. A terminal bonus is payable at end of contract. Free accommodation is provided by the Board. Cost-of-living allowance is payable and an initial outfit allowance of £S50. Free air passage on appointment for official and family is granted. Leave accrues at the rate of seven days per month. There is no income tax in the Sudan at present.

Write for further particulars and application forms to Personnel Section, Sudan Embassy, Cleveland Row, St. James's, London, S.W.1, quoting reference Senior Mechanical Engineer 4/2312. E6579

PUBLIC APPOINTMENTS

SOUTHERN RHODESIA GOVERNMENT

DEPARTMENT OF LABOUR

VACANCY: INSPECTOR OF MACHINERY

Applicants must be qualified engineers in possession of an approved Certificate in Mechanical or Electrical Engineering or the Ministry of Transport First Class Marine Engineers Certificate, and must have had good all-round experience. The duties will include the inspection of all classes of boilers, elevators and general machinery and previous experience in inspection work of this kind, particularly the inspection and testing of boilers, will be a recommendation.

Salary scale: £1220 by £50 to £1620.

Application forms and further details from Secretary (R), Rhodesia House, 429, Strand, London, W.C.2. Closing date, April 10th. E6541

RHODESIA RAILWAYS

VACANCIES FOR CIVIL ENGINEERS

Vacancies exist for fully qualified CIVIL ENGINEERS for service in the Chief Engineer's Department of the Rhodesia Railways. Preferably single men under the age of 25 years will be considered, but married men not exceeding 36 years of age may apply. Applicants should be qualified with a University Degree in Civil Engineering or hold Corporate Membership of the Institution.

Salary scale between the limits of £850 and £1800 per annum.

Free passage, pension, annual leave with pay, sick pay and good prospects of advancement.

For further particulars of conditions of service apply to:

The London Agent, Rhodesia Railways, 241, Salisbury House, London Wall, London, E.C.2. E6580

NORTHERN IRELAND HOSPITALS AUTHORITY

DOWNSHIRE HOSPITAL, DOWNPATRICK
(A HOSPITAL FOR NERVOUS AND MENTAL DISEASES)

SUPERINTENDENT ENGINEER (GRADE I)

Applications are invited from suitably qualified persons for the above post, the salary for which will be £915 by £30 (4) by £35 (1) to £1070.

Qualifications: Applicants must have served a recognised apprenticeship or have otherwise acquired suitable practical training, and must hold a recognised qualification of technical character, such as Extra 1st, 1st Class Certificate of Competency in Marine Engineering, or equivalent Naval Certificate; City and Guilds 1st Class Certificate in Plant Engineering.

Applicants should have wide and varied experience of installations, operation and keeping of records, of steam raising, mechanical and electrical plant and services. A working knowledge of sanitation codes, water supply systems and building maintenance is required, and the ability to control artisan staff is essential.

A suitable house will shortly be available.

Copy of duties and application form may be obtained from the Secretary of the Downshire Hospital Management Committee, to whom the form should be returned so as to be received by him not later than Thursday, 3rd April, 1958. E6567

NORTH EAST METROPOLITAN REGIONAL HOSPITAL BOARD

SENIOR ASSISTANT ENGINEER (MECHANICAL)

Applicants must be Corporate Members of the Institution of Mechanical Engineers, unless professionally graded in the National Health Service, and should possess experience in a senior capacity in the design of boiler plants, steam, heating, hot water and ventilating systems, and have a sound knowledge of all associated mechanical equipment. Salary, £1010 by £30 (5) by £35 (1) to £1195 per annum, plus London Weighting £50.

The above post offers opportunities to cover the whole field of hospital engineering, but previous experience of this work is not necessary.

Applications, giving age, present salary, qualifications and experience (with dates), together with the names of two referees, should be sent to the Secretary, North East Metropolitan Regional Hospital Board, 11a, Portland Place, W.1, within 14 days. E6572

Classified Advts. continued on page 122

PUBLIC APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH LABORATORIES, LEATHERHEAD, SURREY

ASSISTANT ENGINEERS

Applications are invited for the appointment of ASSISTANT ENGINEERS, to work at the Research Laboratories at Leatherhead, Surrey, on a wide range of problems associated with conventional and nuclear power stations. Present investigations concern heat transfer in nuclear fuel elements and heat exchangers, electrostatic precipitators, cooling towers and boiler feed pumps.

Candidates for senior vacancies should have an Honours Degree, with previous research experience ; for other vacancies a Pass Degree or H.N.C. with appropriate experience, would be acceptable but importance is attached to ability to apply fundamental knowledge to a wide range of problems.

Salary according to ability and experience. Second Assistant £1160–£1510 per annum, Third Assistant £1055–£1265 per annum, Fourth Assistant £820–£995 per annum, General Assistant £550–£725 per annum.

Application forms from I. G. Ellis, Personnel Officer, Central Electricity Generating Board, 24/30, Holborn, London, E.C.1, to be returned by 2nd April, 1958. Quote reference ENR/83. E6555

COMMONWEALTH OF AUSTRALIA

THE SNOWY MOUNTAINS HYDRO-ELECTRIC AUTHORITY

invites applications for the position of

CHIEF CIVIL ENGINEER

Salary—£3800 (Australian)

Applicants must possess recognised professional qualifications and have wide experience in the investigation, design and construction of major civil engineering works.

The Chief Civil Engineer is directly responsible to the Authority for the management and conduct of the Authority's civil engineering activities, including the co-ordination and integration of the work of the Civil Design Division, the Major Contracts Division, and the Scientific Services Division.

Only those with successful experience in high executive positions and with proven engineering and administrative ability, will be considered.

Information on superannuation, leave and other conditions of service is available on application to the Authority's London Representative, Australia House, Strand, W.C.2, London.

Headquarters of the Authority is at Cooma, New South Wales, where housing on a rental basis will be available for the successful applicant on taking up duty.

Applications, stating name, age, marital status, present position and salary, together with full and detailed particulars of past experience, should be addressed to the Business Manager, Snowy Mountains Hydro-Electric Authority, Post Office Box 332, Cooma North, N.S.W., Australia, and sent by airmail. Applications close on 18th April, 1958.

E6549

PUBLIC APPOINTMENTS

LIVERPOOL REGIONAL HOSPITAL BOARD

ENGINEERING ASSISTANTS

Applications are invited from suitably qualified persons for the following permanent pensionable appointments on the staff of the Regional Engineer :—

(a) ENGINEERING ASSISTANT (Mechanical)—Grade I

Applicants must be conversant with the design of heating and ventilation systems in hospitals or buildings and the preparation of estimates, drawings and specifications

(b) ENGINEERING ASSISTANT (Electrical)—Grade I

Applicants should be experienced in the preparation of specifications, drawings and estimates for distribution schemes, electrical installations in hospitals and buildings, and be able to take details of existing installations and have a good knowledge of modern installation practice.

Minimum qualification for the above appointments is the Higher National Certificate in Mechanical or Electrical Engineering.

Commencing salary for each post within the scale £655–£965 per annum, dependent on age and previous relevant practical experience.

Applications, stating age, qualifications, experience, present and previous appointments, with names and addresses of three referees (two technical), stating the post applied for, to me at 19, James Street, Liverpool, 2, not later than 27th March, 1958.

VINCENT COLLINGE,
Secretary to the Board.

E6469

TYNE IMPROVEMENT COMMISSION

ENGINEERS

The Tyne Improvement Commissioners invite applications from qualified persons for the positions of :

(a) ASSISTANT CHIEF ENGINEER, and (b) SENIOR ASSISTANT ENGINEER, under their Chief Engineer, Mr. R. B. Porter, M.I.C.E.

Applicants for each position must be Chartered Civil Engineers with extensive experience in the design, construction and maintenance of dock and harbour works and installations.

The commencing salary, which will have regard to the qualifications and experience of the successful candidate, will be :

For the position of Assistant Chief Engineer, not less than £2100 per annum.

For the position of Senior Assistant Engineer, not less than £1650 per annum.

Applicants must not be less than 32 years of age nor more than 45 years of age on the 1st January, 1958.

The person appointed will be subject to the provisions of the Commissioners' superannuation scheme ; will be required to reside in the district and to devote himself exclusively to the service of the Commissioners.

Applications, on a prescribed form, copies of which may be obtained from the undersigned, will be received up to the 10th April, 1958, and should be addressed to the Secretary endorsed to indicate the position for which application is made.

Canvassing will be a disqualification.

R. N. EGGLETON,
Secretary.

Bewick Street,
Newcastle upon Tyne, 1,
6th March, 1958. E6477

TENDERS

CITY OF PLYMOUTH

CIVIC CENTRE

TENDERS are invited from contractors for the CONSTRUCTION SUPPLY, DELIVERY and PLACING in POSITION of THERMAL STORAGE VESSELS of 32,000 gallons capacity for the Proposed Civic Centre.

Applications to be made to the Consulting Engineers, Messrs. Hoare, Lea and Partners, 5, Headland Park, Plymouth, from whom the drawings and specification may be obtained.

No Tender received after noon on Monday, 31st March, 1958, will be considered. No Tender will be received except in a plain, sealed envelope addressed to the Town Clerk, Town Clerk's Office, Pounds House, Plymouth, and bearing the words "Tender—Civic Centre Thermal Storage Vessels," but no name or mark indicating the sender. E1725

TENDERS

INDIA STORE DEPARTMENT

SINGLE SPINDLE AUTOMATIC SCREW MACHINES

The Director General, India Store Department, Government Building, Acton, London, W.3, invites TENDERS or the SUPPLY of :—

SINGLE SPINDLE AUTOMATIC SCREW MACHINES, capacity as follows :

(1) One 12mm. Round.
(2) One 18mm Round.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not returnable. Cheques should be made payable to High Commission of India. The application for Tender forms should state reference : 2090/57/1/SM/Eng.2.

Tenders, complete with specifications, are to be submitted by 1st May, 1958. E6544

CARMARTHEN RURAL DISTRICT COUNCIL

EASTERN AREA WATER SCHEME—SECOND INSTALMENT

The Council invite TENDERS from experienced Contractors for the following work :—

CONTRACT No. 1.—The SUPPLYING, EXCAVATING for, LAYING, JOINTING, MAINTENANCE and ANCILLARY WORK of the following PIPELINES. Approximately 900 lineal yards of 5 inch diameter and 7400 lineal yards of 3 inch diameter, spun iron pipes with flexible joints.

The general conditions, specification, bill of quantities and form of Tender for this Contract prepared by the Engineers, Herbert Lapworth Partners, 25, Victoria Street, Westminster, S.W.1, may be obtained from the undersigned upon application, on receipt of a cheque for £3 made payable to the Carmarthen Rural District Council, which sum will be returned on receipt of a bona fide Tender.

Tenders, together with all documents received, are to be enclosed in a sealed cover, endorsed "Eastern Area Water Scheme, Second Instalment, Tender for Contract No. 1—Pipelaying," and addressed to the undersigned and delivered not later than 10 a.m. on Monday, 28th April, 1958.

Only Tenders from firms experienced in this type of work will be considered.

The Council do not bind themselves to accept the lowest or any Tender.

JOHN JONES,
Clerk of the Council.

Rural District Council Offices,
Spilman Street,
Carmarthen.
14th March, 1958. E6562

INDIA STORE DEPARTMENT

HIGH PRECISION JIG BORER

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

HIGH PRECISION JIG BORER, similar to "LINDNER" Model LB 14. Working surface of table 800 × 400mm. Max. and Min. distances between table surface and boring spindle 540 and 80mm. Spindle speeds 70–2000 r.p.m.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The applications for Tender forms should state reference 2100/57/1/ENG.3.

Tenders, complete with specifications, are to be submitted by Thursday, 1st May, 1958. E6520

INDIA STORE DEPARTMENT

ONE UNIVERSAL THREAD GRINDING MACHINE

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

ONE UNIVERSAL THREAD GRINDING MACHINE, 400mm. centres by 250mm. maximum grinding diameter.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The applications for the Tender forms should state reference 2099/57/ENG.3.

Tenders, complete with specifications, are to be submitted by Thursday, 1st May, 1958. E6521

EDUCATIONAL

IMPERIAL COLLEGE

BURSARIES IN HIGHWAY ENGINEERING provided by the Rees Jeffreys Road Fund, tenable from October, 1958. Value from £460 to £760 per annum, including fees.

Further particulars from the Registrar, Imperial College, London, S.W.7. Closing date, 26th April, 1958. E6540 B

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E721 B

FREE ! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other professional examinations. —E.M.I. Institutes, Dept. E.30, London, W.4. (Associated with H.M.V.) E972 B

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THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8.
E102 B

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A DRAWING BOARD WITH A DIFFERENCE

A drawing board can bring a lot of happiness if the work is varied and interesting and the surroundings pleasant to work in.

Just such a drawing board is now vacant and we would like to see it occupied by a keen DRAUGHTSMAN, age about 25–30, with the right general engineering background. The advantages include a non-contributory pension scheme and other welfare amenities.

Applications are invited by letter addressed to :
THE PERSONNEL MANAGER,
TUFNOL, LTD.,
PERRY BARR, BIRMINGHAM, 22B.
E1730 A

A SENIOR FOREMAN is required to take complete charge of the jobbing section of an old-established Iron Foundry situated in South Wales. The Foundry produces medium to heavy engineering castings. It is essential that the applicant should be a good organiser, fully conversant with modern methods of production and capable of preparing his own estimates. Apply, giving full particulars of age and experience.—BOX No. E1732, "The Engineer." A

A WELL-KNOWN NUCLEAR POWER COMPANY has a first-class opportunity available for a SALES EXECUTIVE. Applications are invited from fully qualified Engineers who have experience in the field of power generation and supply, together with a high degree of administrative ability. The successful candidate will be required to travel at home and overseas in the pursuit of business and will have some executive responsibility under the Company's Commercial Manager. Applications will be handled in strict confidence and should give a summary of education, technical training and business experience. —BOX No. E6566, "The Engineer." A

APPLICATIONS ARE INVITED for the following appointments at the CLAYDON, SUFFOLK, Works of

THE BRITISH STEEL PILING CO., LTD.

SENIOR DESIGNER DRAUGHTSMAN (Minimum qualifications H.N.C. or equivalent.) Age group 28–35 years. Candidates should be capable of accepting responsibility for complete projects.

MECHANICAL DRAUGHTSMAN (Young) (Minimum qualifications O.N.C.) Required for Research and Development Team.

THESE APPOINTMENTS ARE PERMANENT AND PROGRESSIVE IN AN EXPANDING ORGANISATION, and the successful candidates will be engaged on interesting work in connection with special crane type structures, hoisting machinery (steam, diesel, electric) and contractors' plant.

Contributory pension scheme in operation. Good canteen facilities. Salary in accordance with qualifications and experience. The works are situated 15 minutes bus ride from the centre of Ipswich.—Applications to the Personnel Officer at the above address. E6404 A

ASSISTANT WORKSHOPS ENGINEER is required at the Avonmouth Works of Imperial Smelting Corp., Ltd. Duties will include deputising for the Workshops Engineer in his absence and assisting generally in the supervision of 5 foremen and approximately 140 tradesmen, labourers, &c., employed in the central workshop, e.g. Machine Shop, Construction Shop, Loco Sheds, &c., on the maintenance of heavy engineering equipment from metallurgical and chemical plants. It is desired to appoint a person qualified either by apprenticeship and Grad.I.Mech.E. or, alternatively, a Degree with post-graduate engineering experience, but in either case, two years' experience in the field of heavy engineering, i.e. chemical engineering, heavy chemicals, mining engineering or comparable branch in H.M. Forces will be required. Previous workshops and/or supervisory experience would be an advantage. —Request for application form to Personnel Manager, Imperial Smelting Corp., Ltd., St. Andrew's Road, Avonmouth, Bristol, quoting reference AWE/TE. E6578 A

CIVIL ENGINEER (age about 30 years) required for Consulting Engineers' office in Manchester. Technical qualifications should include a Degree and/or Corporate Membership of the Institution of Civil Engineers ; varied experience an advantage. Technical reports following Civil Engineering or industrial accidents, commenting on safety of method of work, compliance with Statutory Regulations, &c.; giving evidence in High Court if litigation ensues.—BOX No. E6446 "The Engineer." A

CIVIL ENGINEERING INSPECTOR required for work in Rhodesia. Civil engineering tunnelling and deep shaft work experience essential. Right experience and good health more important, but would prefer age not over 50. Work is under Consulting Engineers and applicants are asked to indicate nature and periods of previous work and employers. —BOX No. E6553 ," The Engineer." A

A.E.R.E. HARWELL

Vacancy for a

SENIOR ENGINEER

for the Estimating Programmes Group

The Atomic Energy Research Establishment is building at Harwell a Proton Synchroton for the Rutherford Laboratories of the National Institute for research in Nuclear Science. The Project will cost several millions of pounds and will involve unusual buildings, complex mechanical plant and electrical and electronic equipment. The post is a senior one in the Project Team responsible for the design and construction of the machine.

The officer will undertake the drafting of programmes for design and construction and will be required to estimate capital costs involved, to review the progress of the Project and to ensure that designs being produced can be executed within agreed capital expenditures.

The essential requirement is that candidates should have previous experience in sanctioning expenditure and in the drafting of programmes and specifications for a capital project such as a Power Station, Oil Refinery, Major Chemical Plant or Steel Works. Personal qualities of initiative and leadership are being sought, together with ability to negotiate at senior levels.

SALARY : £2,100 – £2,600

Send a POST CARD to Group Recruitment Officer (1104Y/25), A.E.R.E., Harwell, Didcot, Berks., for application form and details.

E6535

SITUATIONS VACANT

APPLICATIONS ARE INVITED FROM ENGINEERS for responsible posts on research and development of Automation Techniques and Production Processes for the engineering industry. Excellent opportunities for those with ability and initiative. Previous experience not essential. Candidates should have an Engineering Degree, Higher National Certificate, or equivalent qualification. Send full details including age, qualifications, experience and present salary, in confidence.—BOX No. E6447, "The Engineer." A

COMPANY IN THE OUTER LONDON AREA concerned with the production of non-ferrous castings (aluminium) sand, gravity and pressure die castings, invites applications from qualified Mechanical Engineers for the position of MAINTENANCE ENGINEER, to supervise general maintenance of machinery, services and installation. Whilst a University Degree in Mechanical Engineering is preferred, consideration will be given to outstanding applicants possessing an equivalent qualification. Candidates must have a general engineering background and sound organising ability. Salary will be on a generous scale commensurate with qualifications and experience. Contributory pension scheme in operation. Write, giving full details of age, qualifications and experience, which will be treated in strict confidence.—BOX No. E6548, "The Engineer." A

CHIEF INSPECTOR required for large engineering company in London area. The company has two divisions engaged on the manufacture of medium/heavy machine tools and mass produced pressings. Extensive engineering experience of precision manufacturing work and technical qualifications to at least H.N.C. required. Candidates must have held an administrative or supervisory inspection post. This is a responsible post offering excellent scope and prospects for an experienced man between 35-50. Write, in the first instance, stating age, education, qualifications and brief details of present and past employment, with salaries earned.—BOX No. E6533, "The Engineer." A

CONSULTING ENGINEERS require CIVIL ENGINEER for work in London, experienced in design of large sewage purification works. Varied experience of more importance than age. The appointment is not a temporary one and under the usual conditions includes staff pensions. Salary not now quoted as it will be based on qualifications and experience of selected applicant. Please indicate these details.—BOX No. E6576, "The Engineer." A

CONSULTING CIVIL ENGINEERS require experienced and qualified RESIDENT ENGINEERS for reservoir contracts, Home Counties.—Write or telephone, L. G. Mouchel and Partners, 38, Victoria Street, Westminster, S.W.1 (ABB 1122). E1731 A

CONSTRUCTORS JOHN BROWN LIMITED invite applications for a post of an EXECUTIVE DIRECTOR. Preference will be given to a man with experience in chemical and petroleum chemical engineering and construction who also possesses proven administrative ability.—Applications should be addressed to the Chairman of the company at 8, The Sanctuary, London, S.W.1, who will deal with them personally and confidentially. E6542 A

DESIGN DRAUGHTSMAN.—Loading Shovel Manufacturers offer attractive and interesting work with young and progressive company on the development of existing models and new projects, to a qualified Design Draughtsman with medium general engineering and transmission design experience, and holding an H.N.C. Permanent and progressive position with good working conditions. Five-day week. Salary commensurate with ability and experience. House available to successful applicant after trial period. Write, giving full details, age, experience and salary required.—F. E. Weatherill, Ltd., Tewin Road, Welwyn Garden City, Herts. E1740 A

DESIGNER-DRAUGHTSMAN with machine tool or allied industry experience, required for interesting development work by progressive firm in satellite town. Housing can be provided. State previous experience, qualifications and salary required —Centec Machine Tools, Ltd., Centec Works, Hemel Hempstead, Herts. E1734 A

DEVELOPMENT ENGINEERS

Exceptional opportunities for three graduate, apprentice-trained, Mechanical Designers in 25/35 age group occur in our organisation. Successful candidates will be given experience of our product before taking responsible positions in our expanding Development and Design departments.

Requirements: Degree or equivalent qualifications and some development and design experience, especially in machine dynamics, strength of materials elasticity, &c.

Staff conditions, salary, pension scheme, &c., are up to the standard expected by those genuinely qualified for these posts.

Candidates should write initially to the Secretary, The British Northrop Loom Company, Limited, Blackburn, Lancashire. E1700 A

DEVELOPMENT ENGINEERS required by large light alloy manufacturing organisation in West London area. Applicants must possess knowledge of light alloy fabrication, have drawing-office and design experience, and at least five years' workshop training. Salary commensurate with qualifications and experience, contributory pension scheme in operation. Write, giving full details.—BOX No. E6481, "The Engineer." A

DRAUGHTSMAN required, preferably with some experience of chemical plant and the operation of shell boilers. Applicants should be of H.N.C. standard. The work is interesting and covers the installation of new and alteration to existing plant, and involves a certain amount of site work. A pension scheme is in operation and a canteen available. —Apply, giving age, qualifications and experience, to Chief Engineer, Lancashire Tar Distillers, Ltd., Liverpool Road, Cadishead, Nr. Manchester. E6480 A

DRAUGHTSMAN, £950 p.a., required for pipework design/layout/detail work in Bristol. Boiler pipework experience essential. Pension scheme.—BOX 2899, Blackford's Advertising, Bristol. E6397 A

DRAUGHTSMAN required, for development work on special-purposes machinery. Wide knowledge of mechanisms essential. Applicant should be aged 21/23 years and have O.N.C.; 5-day week; sick and pension fund.—Apply in writing to Personnel Officer, Osram Lamp Works, East Lane, North Wembley. E6574 A

DRAUGHTSMAN MECHANICAL, under 40, permanent and pensionable post. Used to developing drawings on new plant and maintenance. Salary approximately £900. Please state fully training, &c. —BOX No. E1724, "The Engineer." A

DRAUGHTSMEN

An engineering company in the West Midlands, engaged in the production of a variety of fabricated vessels and tanks, has the following vacancies for Draughtsmen :—

(1) ENGINEER DRAUGHTSMAN, for work in the field of commercial vehicle design and development, and hydraulics. A practical background in the commercial vehicle trade would be an advantage.

(2) SENIOR MECHANICAL ENGINEERING DRAUGHTSMAN, for design work on road and rail transport tankers and aircraft fuelling tankers. Previous experience in the commercial vehicle trade would be an advantage.

(3) MECHANICAL ENGINEERING DRAUGHTSMAN, for design work on fabrication of chemical plant and pressure vessels. Applicants for this post should hold O.N.C. or H.N.C. qualifications or equivalent.

The company operates an attractive staff pension and life assurance scheme, and grants excellent summer holidays. Salaries will be according to age, qualifications and experience, but in all cases will not be less than the minimum A.E.S.D. rates. Applications are invited, which will be treated in the strictest confidence, from suitably qualified persons, who should give full personal details.—BOX No. E6538, "The Engineer." A

DRAUGHTSMEN, MECHANICAL, ELECTRICAL, for engineering consultants. Knowledge of power station work an advantage. Positions permanent, pensionable, five-day week, free lunches.—Write or 'phone, Personnel Officer, Ewbank and Partners, 10/11, Grosvenor Place, Hyde Park Corner, S.W.1 (Sloane 0486). E6575 A

DUST EXHAUST ENGINEER required by Spencer and Halstead, Ltd., 8, West Street, Epsom, to have freedom to show initiative and ability to develop sales, design and installation of large and small contracts in Southern England and South Wales.—Write full details, marked personal, to Technical Manager. E1713 A

ELECTRICAL DESIGNER DRAUGHTSMAN

required by

W. H. ALLEN SONS & CO., LTD., BEDFORD

for the development and design of A.C. and D.C. motor control gear.

This is a permanent appointment on interesting work, with good prospects.

Generous Pension Scheme. Assistance towards removal expenses.

Apply in writing, giving full details of experience, to the Personnel Manager. E6450 A

ELECTRICAL ENGINEERS.—A large Engineering Group who have their H.Q. in Birmingham, have a few vacancies for Electrical Engineers in a Department that provides a consulting service for a group of factories. Applicants should have had good experience on industrial electrical equipment and a Degree or its equivalent in Electrical Engineering is a desirable qualification. The company operates a superannuation scheme. Brief particulars of education, training and experience, should be included in application, addressed to Personnel Manager.—BOX No. E6449, "The Engineer." A

ENGINEER

required in

DEVELOPMENT LABORATORIES

for stress analysis and vibration problems.

Applicants should have a good Degree in Mechanical Engineering, together with ability to make a mathematical approach to problems. Some experience in industry and in the use of electronic equipment is desirable.

The position carries an attractive starting salary and provides excellent opportunities for further advancement. Staff pension fund.

Apply in writing, stating age, qualifications and experience, to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/192. E996 A

ENGINEER, to take charge of works services, required by large medium/heavy engineering company in London area, to be responsible to a director for all production services. Responsibilities would include large toolroom, plant and works maintenance, transport, heat-treatment, experimental shops, accident prevention and the control of appropriate supervisory and other personnel concerned with such sections. This is a responsible position demanding a high standard of technical and administrative ability and carrying an appropriate salary. Applications are invited only from persons : (a) over 35 years of age, (b) who have served an engineering apprenticeship and have had good general and technical education to a minimum of Matriculation and H.N.C. standard, (c) who have had not less than 5 years' experience in senior works administrative positions. Write, in strict confidence, with brief but essential details of age, education, present and past employment.—BOX No. E6532, "The Engineer." A

ENGINEER SUPERVISOR required for maintenance and machine shops in rubber factory, E. London. Knowledge of steam plant an advantage.—Write, stating previous experience and salary required, to BOX Z982, c/o Streets, 110, Old Broad Street, E.C.2. E6564 A

ENGINEERING INSURANCE COMPANY has vacancy on its Engineering Staff in Manchester for a qualified ENGINEER experienced in crane design. Age 30–35. Progressive salary. Non-contributory pension and other benefits.—BOX No. E6591, "The Engineer." A

ESTIMATOR required by PETER LIND & CO., LTD., Romney House, Tufton Street, Westminster, S.W.1. Experienced in estimating for civil engineering and reinforced concrete work.—Apply in writing, giving age, experience and salary required. E6453 A

ESTIMATOR required urgently for West London company. Must be experienced in preparation of costs for tank work, piping layouts, pumping plant, &c. Good salary offered consistent with experience. 5-day week. Please apply, quoting reference E/M.—BOX No. E6577, "The Engineer." A

IMPERIAL CHEMICAL INDUSTRIES, LIMITED,

BILLINGHAM DIVISION

Vacancies for

HEAVY CURRENT ELECTRICAL ENGINEERS

Applications are invited from University Graduates up to 32 years of age, with a good Honours Degree in Heavy Current Electrical Engineering and with two or three years' experience in industry. Candidates should be capable of taking control of the running and maintenance of all electrical equipment on a chemical producing works.

These appointments are to our senior staff and carry good starting salaries. A profit-sharing scheme and pension fund are in operation. Assistance can be given towards house purchase and removal expenses in the case of married men.

Write, giving brief details of age, qualifications and experience, to the Staff Manager, Imperial Chemical Industries, Limited, Billingham Division, Billingham, Co. Durham, quoting reference No. W/N/6. E6569 A

Classified Advts. continued on page 124

BOOKS and PUBLICATIONS

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Hydraulic Design and Performance

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In recent years a number of new principles of design for plumbing and drainage works, showing the way to cheaper and more efficient methods, have been developed and proved in practice. Some of the results have been published in technical journals, and the aim of this book is to assemble and amplify this information, so forming a handbook of a type not previously available. Fully illustrated with photographs and diagrams. **10s. 6d.** (*post* 8*d.*)

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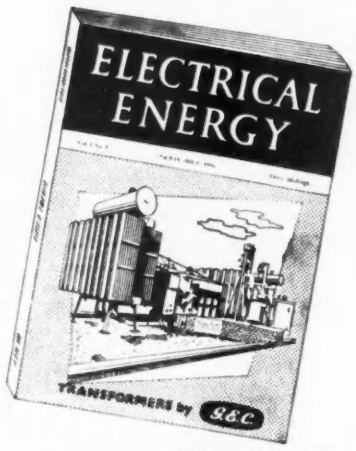

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SITUATIONS VACANT

JACKSON BROS. (OF KNOTTINGLEY) LTD.
require a young ENGINEER for maintenance and development work in modern glass-container works. The post is permanent and pensionable and offers scope for further training and advancement. Previous experience in glass-works not necessary.

Successful applicants must have served an engineering apprenticeship, must be either a Graduate Member of the I.Mech.E., or studying for this qualification, and have had some experience in general works maintainence.

Preference will be given to applicants with a knowledge of modern machine-shop practice and/or automatic machinery maintenance.

Applications to Personnel Officer, Jackson Bros. (of Knottingley), Ltd., P.O. Box No. 2, Knottingley, Yorkshire. E6467 A

JOSEPH LUCAS (ELECTRICAL), LIMITED,
have vacancies for
ASSISTANT DEVELOPMENT ENGINEERS
to work on the design and development of automobile generators, alternators and starting motors and also of motor-cycle electrical equipment, including equipment to be used for racing purposes. Applicants should be of Higher National standard and should have had previous experience in electrical design. Five-day week, staff pension fund.

Apply in writing, stating age, qualifications and experience, to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/176. E995 A

MACHINE SHOP FOREMAN required by a medium-size, but expanding, company of electro-mechanical manufacturers situated in South-East London. Experience in controlling male and female labour on all general purpose machines is essential. The successful applicant will be required to work under the existing foreman and to succeed to that position when he retires in the near future. Write in confidence, giving details of age, experience, qualifications and approximate salary required.—BOX No. E1729, "The Engineer." A

MECHANICAL ENGINEER
required for design of rotating electrical plant, including large hydro-generators. Experience in this class of work desirable but not essential. Applicants must have practical and drawing-office engineering experience. Minimum technical qualifications: Higher National Certificate in Mechanical Engineering. Compulsory pension and superannuation scheme. Assistance given with housing.—Apply, giving details of experience, &c., and salary required, to Manager, Rotating Plant Department, Bruce Peebles and Co., Ltd., Edinburgh, 5. E6463 A

MECHANICAL ENGINEERS — University Honours Graduates or A.M.I.Mech.E. The work entails the investigation of technical problems and the development of plant improvements in connection with a continuous chemical process. Applicants should be between the ages of 25 and 32 and preferably have some years' industrial experience.—Please write to the Personnel Officer, British Cellophane Limited, Bridgwater, Som., and quote Ref. No. E83Er. E6497 A

METHODS ENGINEER required for Engineering Methods Department of J. B. Brooks and Co., Ltd., Birmingham. Experience of presswork, flowline production and shop layout essential. This is an excellent opportunity for a suitably qualified man with initiative to join an expanding and progressive company in which up-to-date equipment and techniques are used.—Apply in confidence, giving details of age, education, experience and salary required, to Personnel Manager, Great Charles Street, Birmingham. E1704 A

METROPOLITAN-VICKERS ELECTRICAL CO. LTD.
WATLING STREET, MOTHERWELL
MECHANICAL DESIGN ENGINEER
A vacancy exists in the X-ray Engineering Department for a Mechanical Designer with experience in light/medium engineering for small batch production. Some electrical background is desirable. Minimum technical qualification, Higher National Certificate or diploma.

Candidates are requested to apply by letter, giving full details of previous employment, qualifications and salary required, addressed to the Employment Manager at above address. E6556 A

MUNICIPAL MUTUAL INSURANCE LTD. has vacancies for ENGINEER SURVEYORS in London, Birmingham, Bradford, Chester and Manchester. Posts are pensionable and permanent to satisfactory candidates, who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications: First Class Ministry of Transport Certificate. Salary: £735–£1060 per annum.—Apply in own handwriting, marking the envelope "Application Engineer Surveyor," 22, Old Queen Street, Westminster, S.W.1. E6587 A

PERSONAL ASSISTANT REQUIRED for the Chief Engineer of organisation with interests in Great Britain and on the Continent. Applicants should be engineers between 30 and 40 years of age, preferably University Graduates, with general experience of modern chemical works practice. They should also be reasonably good draughtsmen, as some design work is involved. Salary will be commensurate with age, experience and qualifications.—Write, BOX Z991, c/o Streets, 110, Old Broad Street, E.C.2. E6563 A

PERSONNEL MANAGER. — Medium-sized general engineering firm in Southern England (55 minutes London) requires capable and experienced Personnel Manager, aged 30–45 years, familiar with Wage Structures, Union negotiations, National Agreements, Factory Acts and Safety Regulations, Apprentice Training, Works Security, Employee Records, Welfare, &c. Knowledge of the engineering industry is essential for this permanent and pensionable position. Apply in absolute confidence with full details of qualifications and chronological account of positions held, to Works Manager.—BOX No. E1741, "The Engineer." A

PETTERS LIMITED
require
SENIOR DRAUGHTSMEN
for
Design and Detail Work
on Diesel Engines.
Excellent working conditions and good salary will be offered to the applicant possessing the right qualifications. Excellent Welfare Facilities and an active Sports and Social Club. Non-contributory Pension Scheme.
Apply, giving full details, to :—
The Chief Personnel Officer,
Petters Limited,
Causeway Works, Staines, Middx.,
Tel.: Staines 1122. E6588 A

PROJECT ENGINEER, with design experience in oil and water coolers and heat exchangers. Excellent salary and conditions.—Apply, Sterling Engineering Co., Ltd., Sterling Works, Rainham Road South, Dagenham, Essex. E1727 A

SALES MANAGER
with knowledge of building or building materials industries, required in Birmingham, for development and supervision of sales organisation marketing specialised building material.
Age 35–40, with good sales experience and preferably a technical qualification appropriate to the construction industry.
Apply in first instance, stating age, experience and qualifications, to :
Personnel Manager (CHW.6),
Thermalite, Ltd.,
133/139, Page Street,
London, N.W.7. E6493 A

SALES MANAGER
TANGYES LIMITED, manufacturers of Hydraulic Machinery, Pumps of all types (including the oil and Chemical Industries), Horizontal Oil Engines, Lifting Tackle, Industrial Heaters, special Machine Tools, &c., require an experienced Sales Manager to take charge of Home and Export Sales Departments.
ESSENTIAL QUALIFICATIONS.—Sound Engineering background, knowledge of and able to undertake Market Research, considerable personal experience of selling to the Engineering Market at home and abroad, control of sales force, including appointment and supervision of Agents. Able negotiate at Director level. Must be prepared to travel overseas at short notice. Languages an advantage.
Remuneration will be in accordance with experience and qualifications. Pension and Life Assurance Scheme available.—Apply in strict confidence, giving full particulars of past and present employment, age, salary, &c., to Assistant Managing Director (Admin.), Tangyes Limited, Cornwall Works, Smethwick, Birmingham. E6539 A

SENIOR DRAUGHTSMAN required for Drawing-Office Section engaged on the application of small diesel engines to marine propulsion. Experience on this type of work is essential. There is every likelihood that this section will expand considerably in the near future and the successful applicant will have the opportunity of promotion to Section Leader. Excellent salary and conditions of employment, including non-contributory pension scheme.—Apply in writing, giving full details, to the Chief Personnel Officer, Petters, Ltd., Causeway Works, Staines, Middx. (Tel.: Staines 1122). E6589 A

SENIOR MANAGER.—A steel works with an expanding trade in section semis and rounds, wishes to engage a Senior Manager to supervise their finishing and despatch departments. Applicants should be technically qualified and have a working knowledge of modern industrial engineering techniques. Preference will be given to men with experience of roller straightening and ancillary processes. The post is progressive and there is a pension scheme and free life assurance scheme in operation.—Applications, with full details of age, qualifications and experience, to BOX N4878, W. H. Smith and Son, 19–21, Corporation Street, Birmingham, 2. E6561 A

STEAM PLANT SUPERINTENDENT wanted for Canadian-owned 12,500kW. public utility in Georgetown, British Guiana. Age 30-40, family man preferred. H.N.C. or, failing that, O.N.C., desirable. Good experience with oil-fired boilers and steam turbines essential. Salary equivalent of £1680 per annum. Free passages both ways; three months' leave at end of three-year period; interim local leave; house with electric cooker and refrigerator provided at nominal rental.—Applications, in writing only, with brief qualifications, to Messrs. Mackness and Shipley, Parliament Mansions, Abbey Orchard Street, London, S.W.1, who will provide full particulars before interview. E6434 A

SENIOR TECHNICAL SALES ENGINEER
Long-established Engineering company requires, for a new Division at Head Office in pleasant surroundings, a qualified and experienced Engineer.

Applications are invited for this interesting and progressive post from men aged 27–35, experienced in flow control and instrumentation; sequence and remote control; electric, pneumatic and hydraulic operation of medium to light engineering mechanisms.

Interested applicants, if adaptable but skilled in only one of these requirements, will receive every consideration. The successful applicant will be responsible for preparation and submission of schemes. He will work closely with the field sales force and visit customers with them when necessary.

There are pension and group life assurance schemes and good canteen facilities. Housing assistance is given where necessary. Own staff know of this advertisement.

Reply in confidence in tabulated form, stating age, present or expected salary, education, qualifications and experience.—BOX No. E6590, "The Engineer." A

SURVEYOR REQUIRED, for service in Iraq. Must be highly experienced in instrument work for precise triangulation surveys and in computing the same, which he would be doing personally. Should also have sufficient experience of level and traverse surveys to check the work of survey companies. Free passage at beginning and end of contract, including families. One month's leave on full pay for each five months' service. Housing and heavy furniture provided. Salary in range £125–£175 per month according to service. Two years' contract offered in the first instance, with possibility of extension.—Apply in writing, to Binnie, Deacon and Gourley, Artillery House, Artillery Row, Westminster, S.W.1. E6534 A

TECHNICAL ASSISTANT required for interesting and varied work in Heat Exchange Test Department. H.N.C. standard; post-Graduate experience also offered in this field. Write, stating age, experience and salary required.—BOX No. E6528, "The Engineer." A

TECHNICAL ASSISTANT required for Sales Office at a large Engineering Works in the Leeds area, dealing with extensive range of new and reconditioned Hydraulic and Rubber Machinery. Preferably with works and drawing-office experience. Contributory pension scheme and canteen. Apply, stating age, experience, training and salary required. —BOX No. E6543, "The Engineer." A

TENDERING AND CONTRACT ENGINEERS are required by the General Engineering Division of Brush Electrical Engineering Company Limited, Loughborough, one vacancy being available in each of the following sections :—

Steam Power Stations
Diesel Power Stations
Industrial Electrical Applications

These are office appointments, which offer considerable scope for the exercise of initiative, and in which allied experience abroad would be an advantage. Applications will be welcomed from engineers who lack the necessary commercial experience, but feel that given the opportunity they would enjoy this type of work. There are no age limits and a non-contributory staff pension scheme is in operation.

Applications should be addressed to the Chief Personnel Officer, Brush Electrical Engineering Co., Ltd., Loughborough, Leics. Interviews can take place in a number of large towns by arrangement. E6545 A

TRINIDAD.—W. R. GRACE & CO. are seeking men to fill the following positions in their new fertiliser factory, at present under construction in Trinidad :

PLANT SUPERINTENDENT, who will direct and control the plant output and be responsible for efficiency of operations. Candidates should have ten years' experience in the chemical industry, of which part must have been in a synthetic ammonia plant. They should have supervisory experience, with responsibility for a complete plant or section of a large chemical works. A Degree or Corporate Membership of Chemical or Mechanical Engineers would be an advantage.

ENGINEERING SUPERINTENDENT, to direct and control plant engineering and maintenance and construction activities. Candidates should have ten years' experience in engineering and maintenance in a large chemical works, with five years' supervisory experience. Degree or Corporate Membership would be an advantage.

MANAGERS for (1) Ammonia, (2) Urea and (3) Sulphuric Acid and Ammonium Sulphate Plants to direct and control the outputs of these plants, responsible to the General Plant Superintendent. Candidates for these posts should have ten years' experience in a chemical works, of which five should have been in a supervisory capacity in a plant producing one of the above chemicals.

TECHNICAL SUPERINTENDENT, to direct all aspects of analytical control, standards of product quality and process engineering functions. Will also advise on new investment possibilities. Candidates should preferably have a Degree in Chemical Engineering or Membership of Institution of Chemical Engineers. They should have supervisory experience of a chemical analytical laboratory and a process engineering department, and experience in ammonia production will be an advantage.

AREA ENGINEER, to be responsible to Engineering Superintendent for plant engineering and to co-ordinate plant maintenance in a section of the factory. Candidates should have five years' industrial experience, of which three years should have been in maintenance of a chemical plant or similar installations employing large compressors. An Engineering Degree or Graduate or Corporate Membership of Engineering Institution is required.

The above appointments are permanent and carry periodic home leave. Applications will be treated in strict confidence and should be sent to : Personnel Officer, Grace Brothers Ltd., 143/9, Fenchurch Street, London, E.C.3. E6554 A

TRANSFORMER DESIGN ENGINEER
Applications are invited to fill vacancies in the Distribution Group of the Transformer Design Department of Bruce Peebles and Co., Ltd., Edinburgh, 5. Salary commensurate with qualifications and experience. Superannuation and production bonus schemes; 5-day week.—Apply to Chief Transformer Designer. E6462 A

THE CHESTERFIELD TUBE COMPANY require DESIGNER-DRAUGHTSMEN, preferably experienced in medium and heavy engineering handling equipment. Excellent opportunities and scope for the right men. Salary according to qualifications and experience, permanent position, five-day week, contributory pension scheme, canteen facilities, &c.—Apply, stating age, details of past experience and salary required, to Personnel and Welfare Department, Derby Road, Chesterfield. E6536 A

TURNER BROTHERS ASBESTOS CO., LTD., ROCHDALE, LANCASHIRE, invite applications for a vacancy which has arisen in their TECHNICAL SALES DEPARTMENT. The successful applicant will have had a sound engineering training, along with some experience of allied sciences; he will be in the 30–37 age group and be prepared to travel extensively in the United Kingdom.—Applications, giving full particulars, should be made in writing and addressed to the Personnel Manager, endorsing envelope "Sales Technical." E6537 A

THE ATOMIC POWER DIVISION,
Construction Department of the
ENGLISH ELECTRIC COMPANY, LTD.,
has the following vacancies for Planning Engineers :—

1. MECHANICAL ENGINEER—with knowledge of constructional procedures, services and programmes.
2. ELECTRICAL ENGINEER—with general knowledge of plant, distribution, control circuits and instrumentation.
3. GRADUATE ENGINEER—to assist in the preparation of design, development and manufacturing programmes.

Successful candidates are assured of interesting and varied work associated with the construction of large nuclear power stations.

Applications, stating age, experience and qualifications, should be addressed to Dept. C.P.S., 336/7, Strand, W.C.2, quoting ref. E1894H. E6526 A

MSL have been retained to advise on the appointment of a

GENERAL MANAGER

for a thriving engineering company in the home counties which has increased its turnover fiftyfold in the last ten years and now leads all competitors in its field. Products are in the medium engineering range.

The General Manager will be responsible for the entire executive management of the company with particular emphasis on technical improvements in manufacturing and design.

Candidates must have a good record of general management in a small engineering company or of works management in a company employing more than 1,000 on batch production of medium engineering products. Qualifications required are A.M.I.Mech.E. based on practical apprenticeship. Age about 45.

Starting salary will interest men earning up to £3,000 per annum and remuneration will be linked to profits. Car provided.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.857, to E. P. Kelsall.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E6528 A

SITUATIONS VACANT

CHIEF DRAUGHTSMAN

CHIEF DRAUGHTSMAN required for company manufacturing material handling equipment. Must have good general engineering background and considerable experience of the latest methods of Mechanical Handling.

Good working conditions and salary appropriate to responsibilities.

Apply, with details of positions held, salary required, to :—

W. MUNCEY & CO., LTD., Stirling Road, Shirley, Solihull, Warwickshire.

E6592 A

SITUATIONS VACANT

WILLIAM DOXFORD & SONS (ENGINEERS) LTD. SUNDERLAND

Invite applications from

SENIOR DRAUGHTSMEN

with experience of the Doxford Heavy Marine Oil Engine for positions in their Design Department. The work is varied and interesting, with good prospects, with salaries according to ability and experience. Pension scheme in operation. Interviews can be arranged to suit the convenience of applicants.

Applications, which will be treated as strictly confidential, stating age, qualifications and experience, should be clearly marked "Design Draughtsman," and be addressed to the Chief Draughtsman.

E6479 A

SITUATIONS VACANT

THE NUCLEAR POWER PLANT COMPANY LIMITED

DESIGN ENGINEER

required

This is a senior appointment. Candidates must have a sound knowledge of the fundamentals of turbo-generating plant and conventional power station auxiliaries. Knowledge of control systems will be an advantage.

The appointment will be held at Knutsford and assistance with housing is offered to married men. The Company operates a contributory pension scheme.

Written applications, giving full details of qualifications and experience, should be addressed to :

The Secretary,
The Nuclear Power Plant Company, Ltd.,
Booths Hall,
Knutsford,
Cheshire,

quoting reference TEG/MECH/35.

E6524 A

CJB

Constructors John Brown Ltd

require a

Manager

who will be responsible directly to the Contracts Director of the Company for the management of one of the Company's principal operating divisions.

This division undertakes contracts both at home and abroad for the oil, chemical and allied industries. The contracts embrace engineering, materials procurement and plant construction.

Applications for this post are invited from Engineers who have had extensive experience in the planning and co-ordination of the design and construction of major projects and who can demonstrate that they have a clear understanding of all aspects of project administration and finance and of the duties and responsibilities relating to the management of a division.

THE APPOINTMENT IS BASED ON LONDON and the salary paid will be commensurate with the important responsibilities entailed. A car will be provided. The Company operates a non-contributory Pension Scheme.

The appointment will be made by the Board of Directors and applications should be addressed in the first place to the Contracts Director,

Constructors John Brown Ltd
73, South Audley Street, London, W 1

and should be marked "Divisional Manager"

E104 A

PIPING DESIGNER/ DRAUGHTSMEN

Kellogg's design capacity increased substantially in 1956 compared with 1955. In 1957 it was more than double that o 1955. This indicates that we offer the oil and chemical industries *something* to account for these increases in the volume of our work and in the size of our staff to handle it. That "something" is greater process know-how, more solid design experience, speed and efficiency, and a record of achievement in our business of which we are proud. If you are qualified you can join our team. Our knowledge and our high standards of engineering work will then help in your own development !

Our Piping Designer/Draughtsmen are of a high standard and we therefore can consider only men of equal calibre.

Our permanent staff benefit from above-average salaries, liberal personnel benefits, good working conditions, excellent Social Club, etc.

If you qualify and are interested you are invited to write to, or telephone the PERSONNEL MANAGER :—

KELLOGG INTERNATIONAL CORPORATION

7-10 CHANDOS STREET, LONDON, W.1 *Telephone : MUSeum 4010 quoting ref. 127/G*

E6433 A

WORKS MANAGER

required by

URQUHART LINDSAY & ROBERTSON ORCHAR, LIMITED, BLACKNESS FOUNDRY, DUNDEE

The above Company, which manufactures gearing, general engineering products and medium and heavy machine tools, has a full order book and requires a Works Manager having proven experience and up-to-date knowledge of modern shop floor practice. Capable of directing shop supervision and successfully running a large engineering works with a substantial plant.

The position carries a good salary with appropriate benefits according to ability and experience.

No enquiries to present or past employers will be made without consent.

Applicants are invited to apply direct to The Chairman in strict confidence and should give details of education, training, experience, positions held and suggested terms of employment. Address applications to "W. Walker, Esq., c/o Latham and Company, Walter House, 418/422, Strand, London, W.C.2," and mark envelope "Private and Confidential."

E6527 A

THE NUCLEAR POWER PLANT COMPANY LIMITED

requires two

COMMISSIONING ENGINEERS

The vacancies are for a Steam Turbine Commissioning Engineer and a Boiler Commissioning Engineer. Applicants for the former position should preferably have had steam turbine design for the latter, experience in boiler or heat exchanger experience, and design. Both appointments call for capable Engineers with good practical experience of the installation and commissioning of modern power station equipment.

Written applications, giving full details of qualifications and experience, should be addressed to :—

The Secretary,
The Nuclear Power Plant Company, Ltd.,
Booths Hall,
Knutsford,
Cheshire,

quoting reference CMS/TEG/36.

E6522 A

SENIOR MECHANISM DESIGNER

A new section is being created to deal with the advance design problems associated with mechanisms, comprising pressings, stampings and diecastings destined for mass production. We require an Engineer capable of establishing a small team for this work, and are seeking a man with a good knowledge of kinematics and mathematical analysis combined with practical experience of similar work. The position is permanent and progressive, carrying an adequate salary, pension scheme, &c.

SENIOR DRAUGHTSMEN AND DRAUGHTSMEN

required to staff the new section as described above, and applications are invited from those possessing an H.N.C. or equivalent qualifications and the necessary experience.

The section will be self-contained, located in open country on a main bus route between Birmingham and Coventry.

Applications are invited, giving full details of training and experience, together with salary required, which will be treated in confidence.

Applications should be addressed to:—

Mr. D. N. Walker, Group Chief Engineer,

WILMOT BREEDEN LIMITED,

Amington Road, Birmingham, 25.

E6546 A

Classified Advts. continued on page 126

SITUATIONS VACANT

MICHELIN TYRE CO. LTD.,

Stoke-on-Trent

have progressive openings for

DESIGNER/DRAUGHTSMEN

(*a*) With H.N.C. and preferably Thermo-dynamics endorsement, for interesting work in connection with Works Services—boiler plant, steam and hydraulic applications, pipework.

(*b*) With H.N.C. (mechanical) and experience design of medium to heavy process plant. Some knowledge belt and chain conveyors desirable.

(*c*) With H.N.C. (electrical) or O.N.C., and now studying for H.N.C. for work on motor applications, lighting schemes and general factory electrical services. Good commencing salaries, related to qualifications and experience, are offered, plus a contributory pension scheme, free life assurance and excellent welfare facilities.

Assistance with housing will be given if required.

Please write in confidence to :—(Mr.) A. C. McComble, c/o above, quoting reference B3/E.

E6351 A

THE NUCLEAR POWER PLANT COMPANY LIMITED

ENGINEERS

required

for Commissioning Nuclear Power Station Reactors.

Applicants should hold a Degree in Mechanical or Electrical Engineering and have had subsequent experience in industry.

Training in reactor engineering will be given to selected candidates.

Written applications, giving full details of qualifications and experience, should be addressed to :

The Secretary,
The Nuclear Power Plant Company, Ltd.,
Booths Hall,
Knutsford,
Cheshire,

quoting reference CMS/TEG/37.

E6523 A

DESIGNER-DRAUGHTSMEN

Kellogg's design capacity increased substantially in 1956 compared with 1955. In 1957 it was more than double that of 1955. This indicates that we offer the oil and chemical industries *something* to account for these increases in the volume of our work and in the size of our staff to handle it. That " something " is greater process know-how, more solid design experience, speed and efficiency, and a record of achievement in our business of which we are proud. If you are qualified, you can join our team. Our knowledge and our high standards of engineering work will then help in your own development !

PIPING

INSTRUMENT

ELECTRICAL

PRESSURE VESSELS

HEAT EXCHANGERS

Owing to increased demands for our services, Designer-Draughtsmen in these categories are cordially invited to contact KELLOGG INTERNATIONAL CORPORATION, leading Design and Construction Engineers of world-wide repute in the petroleum and chemical industries. Our permanent staff benefit from above-average salaries, liberal personnel benefits, good working conditions with opportunities for advancement, and excellent Social Club.

Our Designer-Draughtsmen are of a high standard and we therefore can consider only men of equal calibre. We have immediate vacancies in our new additional premises, so if you qualify and are interested, you are invited to write to, or telephone, the Personnel Manager,

KELLOGG

INTERNATIONAL CORPORATION

7-10 CHANDOS ST., LONDON, W.1. *Tel.: MUSeum 4010, quoting ref. 126/G*

E6519 A

SITUATIONS VACANT

MSL have been retained to advise on the appointment of a

CHIEF ENGINEER

for a medium sized engineering company in the West Riding. The company is a member of a group and manufactures light and medium equipment for the horticultural, agricultural and public works markets. He will be responsible to the general manager for restyling and modernising the company's products, for designing and developing new ones and for establishing and maintaining quality standards.

Candidates should be about 35 and must have 3–5 years' experience as designer in some line of engineering products. An engineering degree would be an advantage, but is unimportant compared with the ability to produce imaginative and stylish designs.

Initial salary £1,500–£2,000 with more for an exceptional man : prospects of technical directorship.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.873, to D. M. Sidney.

MANAGEMENT SELECTION LIMITED

17, Stratton Street, London, W.1.

E6547 A

COST CONTROL ENGINEER

Applications are invited from men with an engineering background and some experience in Cost Control or similar work. The responsibilities will include records and analysis of expeditive and handling technical queries in connection with engineering projects. This is an interesting and progressive appointment for an Engineer with an interest in the field of Cost Control.

Excellent conditions of service are offered and assistance with HOUSING can be made available.

Applications, in writing or by telephone, giving full details of age, experience, qualifications and salary required, should be made to :—

The Employment Officer,

BRITISH OXYGEN ENGINEERING LIMITED

Angel Road, Edmonton, London, N.18

Tel.: EDM 3020.

E6573 A

THE RICHARDSONS, WESTGARTH GROUP

The Group is now engaged on a wide range of projects connected with nuclear power and other developments.

ENGINEERS

There are opportunities for men with a minimum standard of H.N.C. to take part in the Design, Test, Development and Commissioning of experimental and new plant.

The posts are permanent and offer encouraging scope and prospects, particularly to people with an inquiring and flexible outlook.

Write, in confidence, to the Group Personnel Officer, Richardsons, Westgarth and Co., Ltd., P.O. Box 2, Wallsend on Tyne, quoting reference number D.–6.

E6565 A

SITUATIONS VACANT

CHIEF

POWER PLANT ENGINEER

A large manufacturing Company in the Midlands intends to appoint a Chief Power Plant Engineer to co-ordinate its engineering and maintenance services as they affect plant for the generation of steam, electricity and compressed air. Candidates, who should be University Graduates, must have a thorough knowledge of thermodynamics and of the design of steam-raising plant, steam and gas turbines and turbo-blowers. In addition, they must have had extensive operational experience of any or all of these types of plant.

Please apply in confidence, giving details of age, experience and qualifications.

BOX No. E6551, " The Engineer." A

SITUATIONS WANTED

ENGINEER willing to take responsibility for Research and Development on Mechanical, Structural or Marine Products or Materials in medium-sized engineering works or shipyard. B.Sc., A.M.I. Mech.E., age 35, experience of design, development and lecturing.—BOX No. E1735, " The Engineer." B

ENGINEERING EXECUTIVE, high academical and technical qualifications, age 39, present Director and General Manager British engineering company in East, engaged fabrication of structural steelwork, railway wagon manufacture and civil engineering, returning U.K., family reasons, seeks suitable employment. Available discussions April. Write.—BOX No. E1733, " The Engineer." B

MANAGER-EX-CHIEF ENGINEER of Cement Factory in Far East, would be interested in a Managerial or Senior Engineering post in Mining, Cement, Irrigation or General Engineering Manufacture. Post in Africa, South America, Mexico or Colonies preferred. Europe not considered. Private companies preferred, but State projects considered if permanent. The applicant is a fully qualified and experienced Manager and Engineer, familiar with machine design, civil and mechanical engineering, land acquisition, accounts, incentive schemes, personnel management, office organisation and drawing-office organisation. Present salary equivalent to £3000 per annum. Highest possible references and particulars will be sent to reliable firms genuinely interested in permanent services. Reason for wanting change is mistrust of political future locally.—BOX No. E1721, " The Engineer." B

AGENCIES

WEST GERMAN COMPANY, representing British manufacturers of rolling mill equipment (heavy rolls, &c.), seeks Additional Agencies for Mill Furnishing equipment.—BOX No. E1728, " The Engineer." D

DRAWING & DESIGN SERVICE

DRAWING AND DESIGN SERVICE.—Design and Development work required (London), for chemical and industrial plant equipment, special purpose machines, jigs and tools.—BOX No. E1720 " The Engineer." S

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E575 MW

Follsain-Wycliffe

THE SPECIALIST FOUNDRY

The Specialist Foundry with own machine shop

for

BLACKHEART MALLEABLE IRON CASTINGS

●

HEAT AND ABRASION RESISTING ALLOY CASTINGS

●

Manufacturers of the

'PULMAC' PULVERISING MILLS

FOLLSAIN-WYCLIFFE FOUNDRIES LTD.
LUTTERWORTH, Nr. RUGBY
Tel. 10, 60 & 152

E985 MW

SUB-CONTRACTING

ACCURATE MACHINING

also on Models and Prototypes, &c.

MILLING **TURNING**
JIG BORING **PLANING**
PRESS TOOLS, JIGS AND FIXTURES
HORIZONTAL BORING

GIVE US YOUR DIFFICULT JOBS

LANDEN (ENGINEERS), LTD.
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075 E871 MW

HEAVY AND MEDIUM MACHINING CAPACITY REQUIRED for Iron and Steel Castings and Steel Forgings, in small and medium batches, within reasonable distance of London. Please supply full details of equipment available.—BOX No. E6499, "The Engineer." MW

KELLERING and Profile Milling in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft. by 8ft. max. size. We are die copiers to the trade.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry Knottingley, Yorkshire (Tel.: Knottingley 2743/4). E948 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design and development undertaken. A.I.D. Approved.—Bowyer, Smyth and Partners, Ltd., Vineyard Walk, Clerkenwell, E.C.1 ('Phone, TERminus 5113/4). E650 MW

BUSINESSES and PREMISES

TO LET, JUNE, 1958, Winchester District, between 100,000 and 150,000 superficial feet, suitable for research, industrial, administrative or storage purposes.—Apply, R. H. and R. W. Clutton, East Grinstead, Sussex. E6156 L

BUSINESS OPPORTUNITIES

OLD-ESTABLISHED ENGINEERING FIRM situated in the South West, open to consider complete Manufacture of Additional Lines. Own pattern shop, ferrous and non-ferrous foundries, machine, plating and assembly shops. Would consider manufacture under licence.—BOX No. E6585, "The Engineer." G

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 ('Phone, SLOane 5259). E112 K

PATENTS

THE PROPRIETOR of British Patent No. 723,197, entitled "STONE-CUTTING CABLE SAW," offers same for Licence or otherwise to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 14 E, Jackson Blvd., Chicago 4, Illinois, U.S.A. E6593 H

MISCELLANEOUS

PHOTOGRAPHIC SERVICES

A.S.P. (ENGINEERS), LTD., 129, Balham High Road, London, S.W.12 (Balham 3426), specialist photographers for the engineering industry. Photographic Work Undertaken, London Area, and 100 miles radius—architectural features, civil engineering and building work, machinery, models and transport, etc. Specimens available on request. E1630 I

MACHINERY Etc. WANTED

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Moseley Road, Birmingham 12. VIC. 1278 1279 1270, 0856. E123 F

WANTED, Tube Expanding Machine, Tube Cleaning Machine, 6in. to 8in. Screwing Machine, with collapsible head.—Fred Watkins (Boilers), Ltd., Coleford, Glos. E997 F

FOR SALE

FRED WATKINS (BOILERS), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic, 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Broomwade 510 cu. ft.; Tilghman 365 cu. ft.; Broomwade 300, 200 and 130 cu. ft.; all motorised.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.-70ft. extendable jib; 4-ton Coles Diesel-Electric; 3-ton Jones Super 40 (3); Neals 2-ton Diesel, 20ft. jibs (2); Derrick, 5 ton Butters Electric travelling type, 90ft. jib; 5-ton Wilson Electric, 70ft. jib; 3-ton Rushworth Flectric, 65ft. jib; Steam Loco., 18-ton Brownhoist, 50ft. jib; 10-ton Coles, 40ft. jib; 8-ton Wilson, 35ft. jib; 5-ton Smith, 50ft. jib; 5-ton Cowans Sheldon, 50ft. jib; 5-ton Grafton, 38ft. jib; E.O.T. Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris; 10-ton Vaughan, unused, 40-60ft. span; 5-ton Henderson, 24ft. 7½in. span, 1946; 5-ton King 29ft. 3in. span; 2-ton Morris, 18ft. span; 2-ton Smith, 34ft. span.
RAILWAY MATERIAL.—150 h.p. Stephenson Diesel Loco., fluid flywheel drive; Ruston 80/88 h.p. Diesel Loco. electric start, flameproof; Peckett 14in. by 22in. and 7in. by 12in. Steam Locos.; 3 miles 20 lb. Track, 24in. gauge bogies, turnouts locos., &c.
STEEL PIPING.—50,000ft., 2in. Galvanised new; 60,000ft., black new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50 000 gallons.
MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¼in.; Robertson Straightening Rolls, 8ft. 6in. by ¼in.; Berry Bending Rolls, 7ft. by ¼in.; Tangye 300-ton Hydraulic Horizontal Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, ¾in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers.

SLING ENGINEERING WORKS,
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E366 G

SKLENAR Oil-Fired Melting Furnace, type 1 ton, arranged to tilt. View by appointment. Offers.—BOX No. E6568, "The Engineer." G

STACKING MACHINES.—Platform elevates to 8ft. to 14ft., according to required size. On wheels with drawbar. Saves time, labour and space. Ex. M.O.S. Unused. From £75 (less than half price).—Full particulars from Speed Electrics, Eastwood, Notts. E1737 G

FOR SALE

TWW

NEW ELDAIR PB 5/36 MECHANICAL PRESS BRAKE, capacity 5ft. by 12 g. between frames, 400/3/50.
NEW RUSHWORTH R.75/8 MECHANICAL PRESS BRAKE, capacity 8ft. by ¼in. M.S. between frames, 400/3/50.
NEW PEARSON 10ft. by ¼in. ELECTRO-HYDRAULIC GUILLOTINE, hydraulic hold down, 400/3/50.
NEW RUSHWORTH 8ft. by ¼in. OVERCRANK GEARED GUILLOTINE SHEARING MACHINE 400/3/50.
TAYLOR and CHALLEN 1623 GANG SLITTER, capacity 15in. wide by 14 g., excluding electrics.
SCRIVEN S/E. PUNCHING MACHINE, to punch four 13/16in. holes by ¼in., gap 20in., 400/3/50.

THOS. W. WARD LTD.
ALBION WORKS - - - SHEFFIELD.
'Phone: 26311. 'Grams: "Forward." E214 G

HYDRAULIC PRESSES

Large stock of modern Presses up to 10,000 tons capacity, for Forging, Forming, Extruding, Baling and other duties.
Enquiries from the Specialists:—
REED BROTHERS (ENGINEERING), LTD.,
Replant Works, Woolwich Industrial Estate,
London, S.E.18.
Tel.: Woolwich 7611 (6 lines). E6560 G

B.S.A. NO. 12-5 CENTRELESS GRINDER

Maximum dia. 5½in., with power-operated truing attachment and Phillips Magnetic Clarifier.

F. J. EDWARDS, LTD.,
359-361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771
E6459 G

TANGYE HYDRAULIC PRESS

200 ton, 12in ram, 12in stroke, 3ft. daylight, bed 16ft. by 2ft. 6in. wide, complete with pump, electric S.R. motor and starter for 400/3/50.

NORMAC, LTD.,
Pepper Road, Leeds, 10.
Tel.: 77779. E993 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft. 24ft. and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel., Bexleyheath 305). F681 G

ROTARY DRYING KILN, oil fired, 10ft. 6in. long 3ft. 6in. wide, 4ft. 6in. high, weight 2½ tons, suitable for heating to 700 deg. C., drying and heating mineral powders or granules up to ¼in., capacity 8 cu. ft. per hour. Grocott burner. 9in. dia. nickel-chrome heating tube. Variable control for feed and temperature. £400.—BOX No. E1726, "The Engineer." G

FOR SALE

SOAG

LATE TYPE
HEAVY DUTY
POWER PRESSES
IN STOCK

BLISS No. 668 Knuckle Joint, tonnage capacity 1500, platens 39in. by 42in., 3in. stroke, auto. feed, 39in. dia. rotary table, pneumatic cushions; h.p. motor 50.

BLISS Toledo No. 667 Knuckle Joint, tonnage capacity 1200, platens 37in. by 40in., auto. feed, 34½in. dia. rotary table; h.p. motor 35.

COWLISHAW and WALKER Indenting Press, No. EL2½, vee-belt, motor drive through double gearing, all steel, 4 tie-bar type; capacity 600 tons, ram face 29in. by 22in., stroke 2½in.; h.p. motor 30.

WILKINS and MITCHELL 200-ton Double Sided platens 31in. by 24in.,|16in. stroke, 3in., adjustment; h.p. motor 45.

COWLISHAW and WALKER Blanking Press, No. ED6, vee-belt motor drive through double gearing, 4 tie-bar type; capacity 200 tons, ram face 31in. by 22in., stroke 6in.; h.p. motor 15.

BLISS No. 4½ Three-Crank, Double-Action, Cutting and Cupping Press, area of bolster 21in. by 26in., area of cutting slide face 12in. by 16in., area of drawing slide face 8in. by 10in.; h.p. motor 10.

Inspection invited.

Full particulars on any of the above gladly sent on request.

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'Grams: "Sotoolsag," London, S.E.11.
E210 G

NEWALL Model 420 Universal PRECISION THREAD GRINDER, with relieving attachment, internal grinding and diamond dressing attachment and quantity of equipment.

H. BELL (MACHINE TOOLS), LTD.,
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METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.
Motor and gearbox available separately if required.

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SECTIONAL TANK, 48ft. by 48ft. by 12ft. deep with division plate and top cover, capacity 165,000 gallons. Mounted on 40ft. tower. Available ex-site immediately. We can dismantle and re-erect.—Fred Watkins (Boilers), Ltd., Coleford, Glos. E6494 G

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IL CINCINNATI Sliding and Swivelling Head; table size 44½in. by 10½in.; capacity 22in. by 14in. by 10in.

NO. 2 CINCINNATI, medium speed, dial type; table size 52½in. by 12½in.; capacity 28in. by 12in. by 13in.

V3 MASERATI, new, high-speed dial sliding and swivelling head; multi-motor drive; rapid power traverse in all directions by separate motor; table working surface 59in. by 13½in.; capacity 35½in. by 11in. by 18½in.; 20 spindle speeds, 18–2,000 r.p.m.; spindle motor 10 h.p.

NO. 4 CINCINNATI, high speed, dial type; table size 78½in. by 16in.; capacity 42in. by 16in. by 16in.

47 V HERBERT, Kneeless type, multi-motor drive; table 72in. by 17in.; capacity 48in. by 16in.; maximum distance table top to spindle nose 23in.; 16 spindle speeds from 21 to 750 r.p.m.

CV M25 KENDALL & GENT (Kneeless), circular table type; table diameter 30in.; capacity 30in. by 26in. by 32in.

28-60 CINCINNATI Vertical Hydro-Tel; fixed height bed; single power control lever; stepless feed regulation; rapid power traverse; table working surface 83in. by 28in.; capacity 60in. by 30in.; vertical 14in.; 16 spindle speeds from 52–1,300 r.p.m.

PLAIN HORIZONTAL

NO. 2 CINCINNATI, medium speed, dial type; table working surface 48½in. by 12in.; capacity 28in. by 10in. by 19in.

NO. 4 CINCINNATI, medium speed, dial type; table working surface 74½in. by 16in.; capacity 42in. by 14in. by 20in.

NO. 2B BROWN & SHARPE Standard Plain; table working surface 51½in. by 11½in.; capacity 28in. by 10in. by 18½in.

VPF2 PEDERSEN table working surface 51in. by 12in.; capacity 32in. by 9in. by 18in. (new).

28IN. ARCHDALE, General Purpose Model No. 14537; motor drive; table working surface 49in. by 13in.; capacity 28in. by 8in. by 15½in.; rapid power traverse.

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S2 CRAVEN, table size 55in. by 13in.; capacity 36in. by 10in. by 16in.

2FU MASERATI, table size 55in. by 13in.; capacity 36in. by 11in. by 17in.

IN PARKINSON, table size 46in. by 10½in.; capacity 25in. by 9in. by 18in.

PRODUCTION

3/36 CINCINNATI Plain Hydromatic; table size 52½in. by 15in.; travel 36in.

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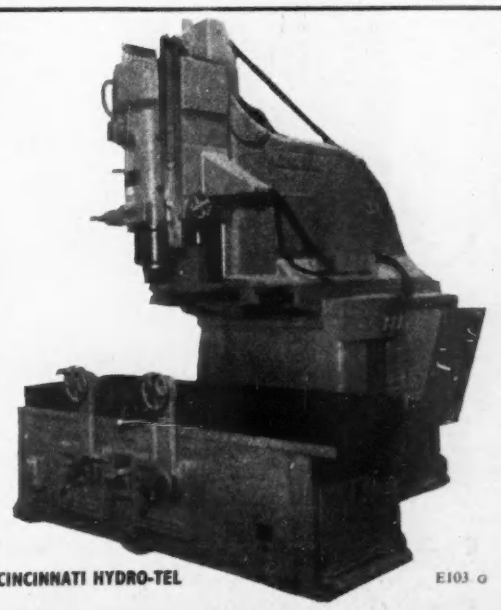
ASQUITH Model H.K.5 Horizontal Duplex Head Keyway and Cotterway Milling Machine for keyways up to 3½in. by 15in.; table working surface 60in. by 10½in.



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Classified Advts. continued on page 128

FOR SALE

600

STEAM TURBO-ALTERNATOR SETS

3000kW., 6600/3/50, MET.-VICK., Pass-out/Condensing Steam Turbo-Alternator Set, date 1948, designed for 340 p.s.i.g initially, 600 deg. Fah. temperature; also suitable for the following duties:

Output/kW.	Pass-out/lb./hour	Lb. Pressure
3000	60,000	40
1800	40,000	110
1800	40 000	

double Pass/out at 1000kW., fully condensing.

2500kW., 440/3/50, B.T.H., speed 3000 r.p.m., 250 p.s.i.g., 630 deg. F., steam consumption approx. 12·8 lb./kW./hr., with surface condenser, circulating pumps, &c. Also suitable for pass-out pressures varying between 18/35 p.s.i.

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Tel.: Shepherds Bush 2070; and
STANNINGLFY, NR. LEEDS.
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28-TON STEAM LOCOMOTIVE CRANE
For Sale

By Brownhoist, 20 U.S. tons, 2 hoist drums, 50ft. jib, high-speed double bogie truck, screw couplers, air brakes, spring buffers. To British rail and loading gauge. Brand new, cased as despatched from makers.

L. NELSON & CO., LTD.,
LUGTROUT LANE, SOLIHULL, WARWICKS.
Tel.: Sheldon 4005. Tel: Sheldon 4443. E1714 G

UNUSED SET OF PLATE BENDING ROLLS, capacity 32ft. by 1in. down to 6ft. by 2¼in. mild steel plate; 75 h.p. roll drive, 40 h.p. screw-down; electrics 400/3/50.—BOX No. E6558, "The Engineer." G

TURBO-ALTERNATOR, B.T.H., 1500kW., 3300V., 3 phase, 50 cycles, for H.P. or L.P. steam at 200/100 P.S.I.G. Complete with surface condenser, valves, switchgear and all ancillaries. £1250.—George Russell (Whitegates), Ltd., 463, Glasgow Road, Wishaw (Phone: Wishaw 4275). E1742 G

"BUTTERS" ELECTRIC DERRICK CRANE. 70ft. jib, lifting 5 tons at 52ft. radius, and 2 tons at 66ft. radius, complete with cabin and Wylie safe load indicator with audible warning. All in new condition. For further particulars apply to The Works Manager, W. H. Allen, Sons and Co., Ltd., Bedford. E6557 G

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One 1-ton Neals Mobile Crane, Ruston diesel engine, mounted on pneumatic tyres, 20ft. jib, fully slewing. In good order. £575.
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One Jones "Super 40" 3-ton Diesel Mobile Crane, 24ft. jib, Ruston engine, on pneumatics. Ex Ministry. Overhauled. £1275.
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Three 7-ton Butters Steam Derrick Cranes, 100/120ft. jibs, two machines of grabbing type. All in very good condition.
One 7-ton Butters Electric Derrick Crane, 120ft. jib, timber cabin, safe load indicator, &c. In good condition.
One 12½-ton Coles Petrol/Electric Fully Mobile Crane, with 45/80ft. jib. New 1950. Reconditioned recently. £5500.
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FOR SALE

10-ton capacity Morris 3-motor, cab-controlled, twin girder, Overhead Electric Travelling Crane, 47ft. span, 440/500V. D.C.
6-ton Morris Ditto Crane, 40ft. span.
2-ton Morris Ditto Crane, 28ft. 6in. span, pendant control, 400/3/50.
10-ton Brand New Morris, 2-motor, O.E.T. Crane Crab, totally enclosed gearing, 440/500V. D.C.
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Cardiff (Tel.: 26100). E6475 G

FOR SALE

6-ton Ransomes and Rapier Standard pet./elec. Mobile Crane on solid rubber tyres.
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5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane, 4ft. 8½in. gauge, 35ft. jib.
WILLIAM G. SEARCH, LIMITED.
WHITEHALL ROAD, LEEDS, 12.
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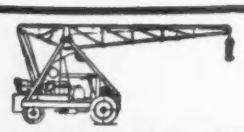

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Tel. No.: Thornton Heath 1783.
Telegrams: "Matolco," Croydon.
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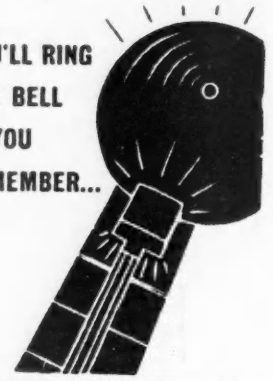

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1.	14×22	040 Barclay	—	160	22
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3.	14×22	040 Barclay	—	160	22
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5.	14×22	040 Barclay	1935	160	22
6.	17×24	040 Bagnall	1934	160	36
7.	17×24	040 Bagnall	1940	160	36
8.	17×24	040 Bagnall	1941	160	36
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10.	17×24	040 Bagnall	1944	160	36
11.	18×26	060 Bagnall	1950	180	40½

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900 TONS GOOD SECOND-HAND B.H. RAILS, 80/85 lb. yard, B.S. Section, chiefly 60ft.
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WADLEY Type EG5 Hand Lever Ratchet Action Shearing and Section Cropping Machine with steel plate frame, on four-wheel truck; shears plates of any length or width up to ½in. thick, crops rounds and squares up to 1¼in., angles and tees at right angles, 3in. by 3in. by ½in., angles and tees on the mitre 2¾in. by 2¾in. by 5/16in., flat bars 6in. by ½in.
STOCK SOILED All-Steel Press Brake, capacity 8ft. by 3/16in., distance between side frames 69in., stroke 3in., arranged for motor drive with electrical equipment for 400/3/50. Weight about 9½ tons.
JOHN HANDS Style SCG, No. 8, Double-Geared, Double-Sided Press, with cast steel body; pressure exerted about 400 tons, stroke 8in., between uprights 26in., bed 24in. by 26in., arranged motor drive. Weight about 10 tons.
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90-ton Electric Travelling Goliath Crane, 106ft. span, 72ft. lift, all lattice steel construction, electrics 400 volts, 3-phase, 50 cycles. Tested by Lloyds to 150 tons.
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AUCTION PROGRAMME

		Main Location	*Auctioneers*
March 24–28	Vehicles, earth moving equipment, cranes, trailers, tractors, motor cycles, etc.	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)
March 26	Miscellaneous stores, including tentage, clothing, blankets, furniture, etc.	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.	BARTLE & SON (Dept. L), 50–52 Merrion Street, Leeds, 2. (Tel.: 2-0898.)
April 1–2	Machine tools and miscellaneous stores, including textiles, clothing, electrical stores, canteen equipment, etc.	M.O.S. Sub-Depot, Lily Lane, Byley, Middlewich, Cheshire. (Sale at New Islington Public Halls, Ancoats, Manchester.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
April 15–18	Machine tools, vehicles and miscellaneous stores, including :—	M.O.S. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
	Saloons and limousines, utilities, service trucks, 200 Fork Lift Trucks, vans, light and heavy trailers, ambulances, Austin "Loadstar" trucks, large quantity of lead/acid vehicle batteries, New Britain bar automatics, Brown & Sharpe S.S. & S.C. lathes, Furnival guillotines, diesel-electric generating sets, electric charging sets, paint spraying and tyre inflation plant, mobile laundry equipment, large quantity of hand tools, roller conveyor, clothing, 520 bell tents and tentage, canvas and webbing equipment, radio and electrical stores, etc.		
April 22	Machine tools, and miscellaneous stores, including M.T. spares, clothing, etc.	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham, (Tel.: 47271.)

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Springs

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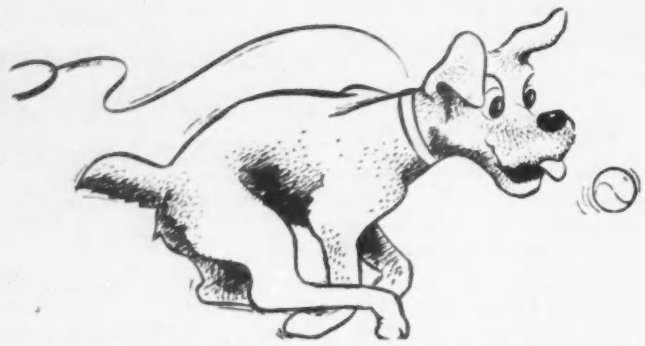

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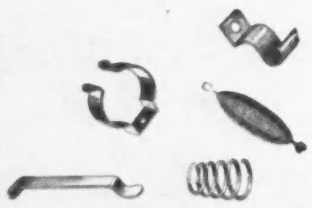

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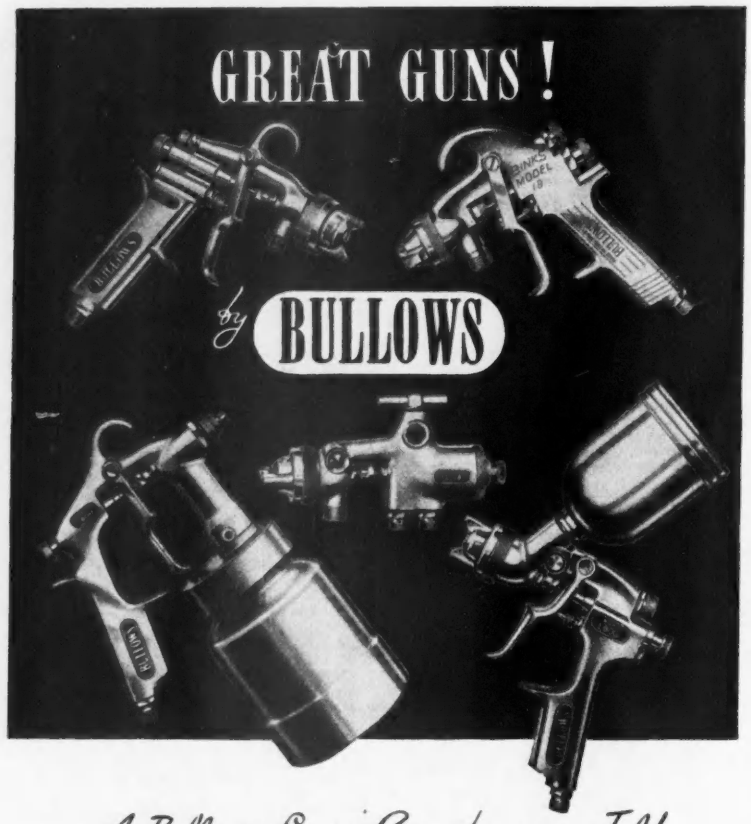

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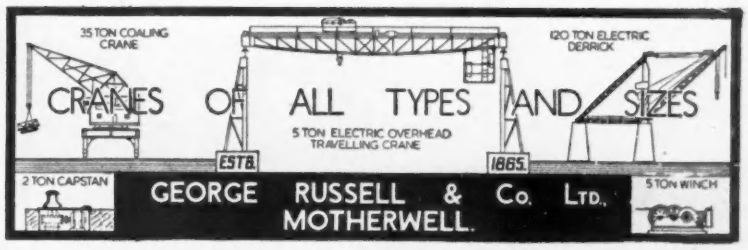

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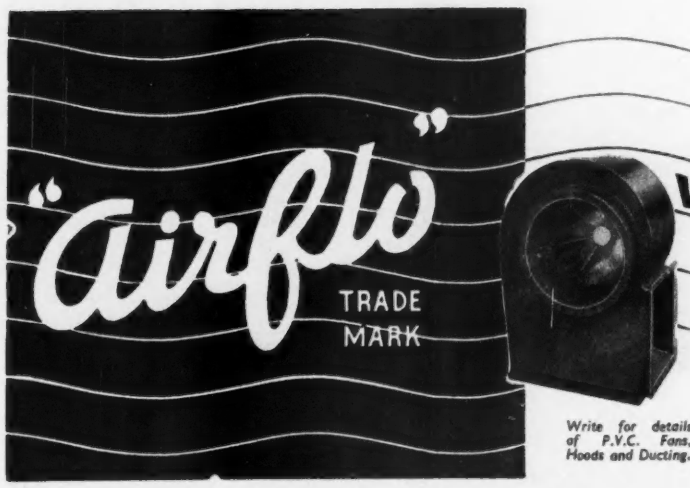

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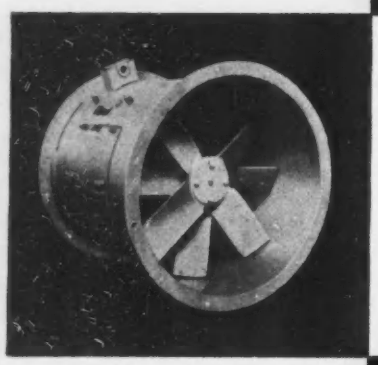

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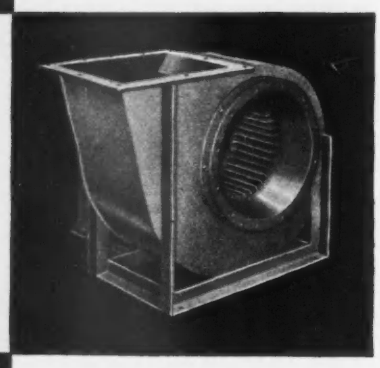

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